Solution to Sample Exam

ENVIRON 805K

December 3, 2017

1.

The precondition of the first and second theorems of welfare economics is the competitive economy. However, in our real world, a competitive economy does not exist due to externalities, monopoly, and asymmetric information. Market failure causes the inefficient level of pollution emission and leads to the severe pollution problems.

2.

(a)

The aggregate marginal damage for the public bad is $12p$ while the marginal saving for the factory is $30 - 3p$.

(b)

In the absence of any regulation or bargaining, the factory will maximize its total saving. Therefore, it will pollute at the level where the marginal saving is 0, i.e., $p = 10$.

(c)

For the whole society, the externalities should be considered. Therefore, at the optimal level, marginal savings should equal the aggregate marginal damage. Let $30 - 3p = 12p$, we have $p = 2$.

3.

B has the lowest cost-effectiveness ratio and therefore is the best choice.

4.

Suppose the maximum amount the city would be willing to pay to preserve the land is p.

$$-p + \sum_{t=1}^{t=50} \frac{100,000}{(1+5\%)^t} \geq 0$$

$$\Rightarrow p \leq \sum_{t=1}^{t=50} \frac{100,000}{(1+5\%)^t}$$

5.

(a)

When $A = 1$, $U(H, 1) = H$. Therefore, $H^* = 15/5 = 3$.

(b)

When $A = 2$ and keep the utility unchanged. We have $H^* = \frac{3}{2}$.

(c)

$\frac{3}{2} \times 5 = \frac{15}{2}$.

6.

Since the island is isolated, the market is purely local. Therefore, the price of the agricultural output will be determined locally. Cleaning up the pollution will increase the supply of the crop and probably reduce the crop price, in both the dirty and the clean area. This results in a reduction in the land price in the clean area, in conjunction with an increase in the land price in the dirty area. Consumers have benefited from cleaner air (through lower-priced products) as well as producers (landowners). Thus the land value change will not fully capture the value of the cleaned air.

7.

(a)

We can investigate the effect of air pollution on people's facemask consumption. For example, we can analyze the following model.

$$Facemask = \alpha AQI + X + \epsilon$$

where $Facemask$ is the consumption of facemasks, AQI is the air quality index, and X is other control variables. α here measures the semi-elasticity of facemask purchases with respect to air quality. It can interpreted as the marginal willingness to pay.

(b)

$VSL = \frac{\$1.5}{8\times10^{-7}-6\times10^{-7}} = \$7.5 \times 10^6$.

8.

- Ambiguity: The amount people offer may not truly reflect their concern and is just for "purchasing moral satisfaction".
- Embedding: People may ignore the existence of substitutions.
- Hypothetical: There is no budget constraint in a hypothetical survey.

9.

(a)

$MS_1(e) = -MAC_1(e) = 5 - e$

$MS_2(e) = -MAC_2(e) = 8 - 2e$

The aggregate saving function is $AMS(e) = \begin{cases} 8 - 2e, 0 \leq e \leq \frac{3}{2} \\ 6 - \frac{2}{3}e, e \geq \frac{3}{2} \end{cases}$.

(b)

The aggregate marginal damage is $AMD(e) = 3e$.

(c)

Let $AMD = AMS$, we have $e^* = \frac{18}{11}$ and $p^* = \frac{54}{11}$.

(d)

$e_1^* = \frac{1}{11}$ and $e_2^* = \frac{17}{11}$.

10.

No.

See Figure 1. The Pigovian fee causes extra deadweight loss. (Refer Page252 of English version of the textbook.)

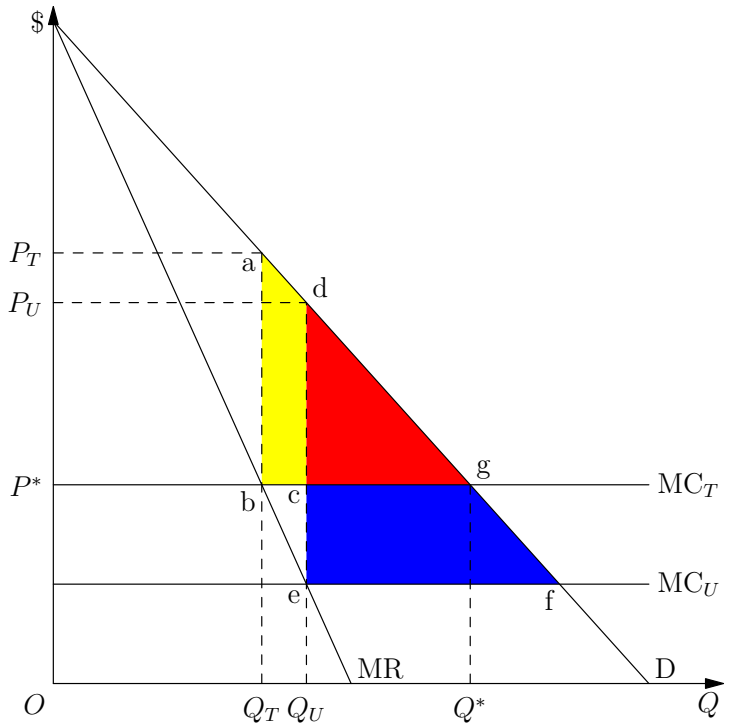

Figure 1: Monopoly and Pigovian Tax

11.

(a)

The Pigovian fee for per unit of emissions is $\$2$.

(b)

The total cost is $TC = Q^2 + 4Q$. Therefore, $MC = 2Q + 4$. Let $MC = 10$, we have $Q = 3$. The emission fee is $3 \times 2 \times 2 = \$12$. The profit is $\$9$.

12.

See Figure 2.

The light shaded area represents inefficiency from emission fee while the dark shaded are represents inefficiency from quantity control.

With uncertainty over marginal costs of emissions, quantity regulations are preferred if marginal damages are more steeply sloped than marginal savings from emissions; emission fees are preferred if amrginal savings are more steeply sloped than marginal damages.

Bonus Question

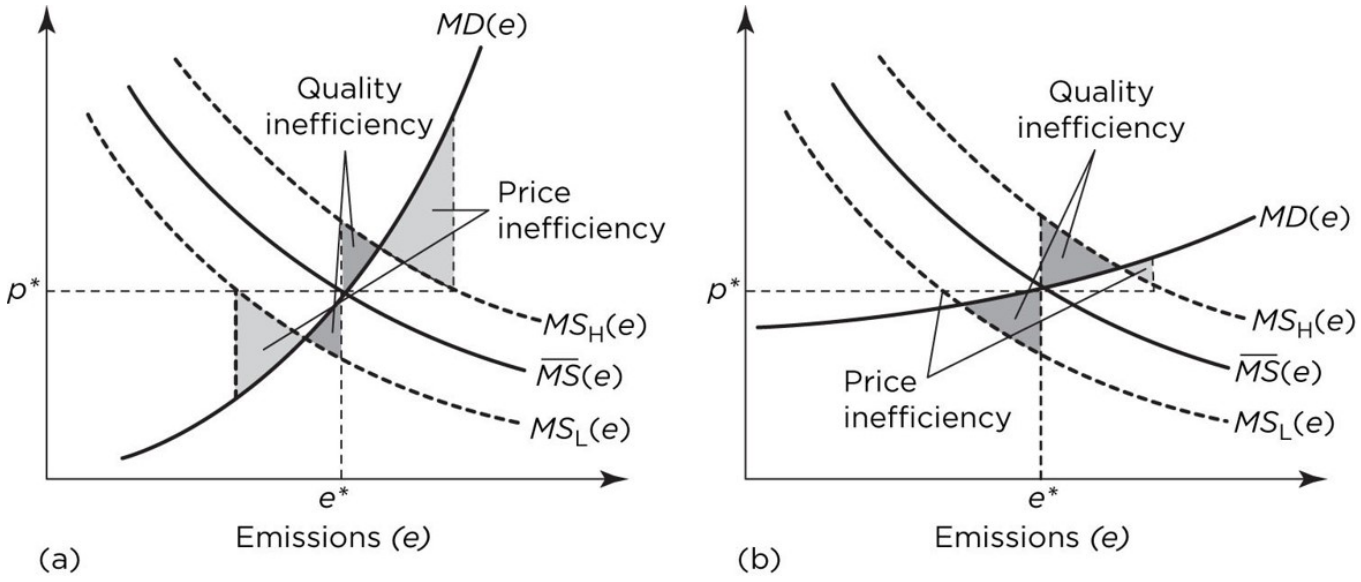

Figure 2: Welfare Losses from Price and Quantity Control

1

- both facilities operate: $\Pi_R(A^*) + \Pi_C(A^*) - \Pi_C(1)$
- car factory shuts down: $\Pi_R(0) - \Pi_C(1)$
- refinery shuts down: 0

2.

$$\begin{cases} \Pi_R(0) - \Pi_C(1) \geq \Pi_R(A^*) + \Pi_C(A^*) - \Pi_C(1) \\ \Pi_R(0) - \Pi_C(1) \geq 0 \end{cases} \Rightarrow \Pi_R(0) \geq \Pi_R(A^*) + \Pi_C(A^*) = 300$$