ECN 275/375 Environmental and natural resource economics
Exercise set 7 – Eirik's suggested answers

Exercise 7.1 – The basic equation of monitoring and enforcement

$\rho = \frac{U_n - U_c}{S}$ is often referred to as the basic equation for monitoring and enforcement.

(a) Explain the terms in the equation.

Answer: U_n and U_c are the respective state dependent payoffs from noncompliance and compliance, S is the penalty if found in noncompliance and ρ is the monitoring probability

(b) Derive the equation from the behavioral rule the expected payoffs from compliance must at least exceed the expected payoffs from non-compliance.

Answer: The expected payoffs from compliance: $E[U_c] = \rho U_c + (1-\rho)U_c = U_c$. Similarly, the expeced payoffs from noncompliance: $E[U_n] = \rho(U_n - S) + (1-\rho)U_n = -\rho S + U_n$. Insert these therms into the behavioral rule that expected payoffs from compliance must at least exceed the expected payoff of noncompliance:

$$E[U_c] \geq E[U_n] \Rightarrow U_c \geq [U_n - \rho S] \Rightarrow \rho S \geq (U_n - U_c) \Rightarrow \rho = \frac{U_n - U_c}{S}$$

Remark: note that for the monitoring probability $\rho \in [0,1]$ to be a valid probability the following conditions must hold: (i) $U_n \geq U_c$, and (ii) $U_n - U_c \leq S$.

(c) How would you introduce a compliance rent into the basic equation? Show that this gives lower monitoring probability than without a compliance rent.

Answer: Introducing the compliance rent: If caught in noncompliance, somebody with an established track record of noncompliance would have to cover the agency's monitoring costs. This would be the same as increasing the penalty for being in noncompliance, (set $S' > S$ in the formula, and the necessary monitoring probability, ρ' (for S'), declines.

(d) How is Gary Becker's "hang the prisoner with probability zero" implemented in the basic formula for monitoring and enforcement?

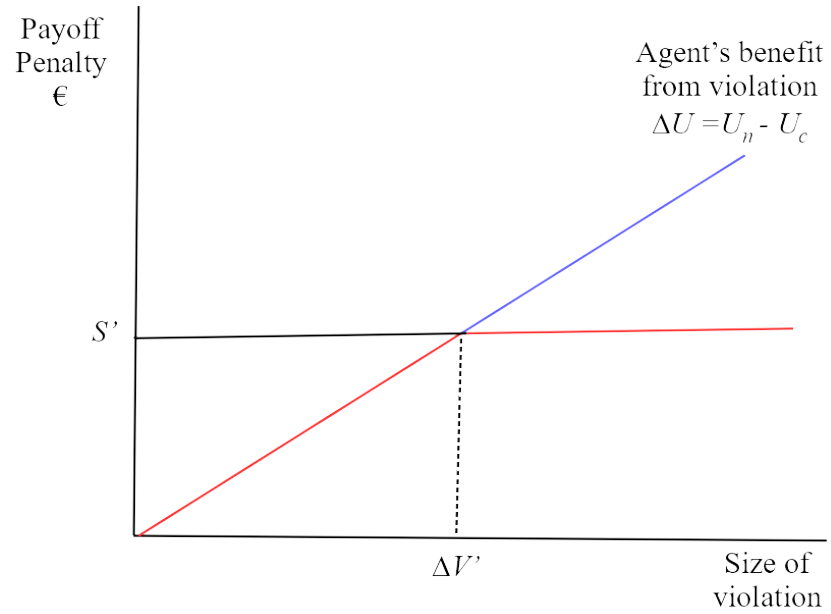
Answer: A death penalty (being hanged) amounts to S being infinite: $\lim_{S \to \infty} \rho = \lim_{S \to \infty} \frac{U_n - U_c}{S} = 0$, i.e., with an infinite penalty, the necessary monitoring probabilities for compliance is zero which means no resources spent on securing compliance in theory.

(e) What are the main difficulties with the "hang the prisoner with probability zero" proposition?

Answer: (i) Under the possibility of type I errors (wrongfully rejecting the null hypothesis – here sentencing an innocent person to death), this violates an ethical principle of modern democracies. (ii) Suppose the violation is minor, and could have taken place by accident (like a pedestrian crossing a road outside the zebra stripes even if one was close by). Then there is no (or at least a poor) match between the expected consequence of the violation and the severity of the penalty. (iii) Excessive penalties implies the accused would be willing to spend more on litigation to reduce the chance of being found guilty → efficiency loss in society.

Exercise 7.2 – The importance of a well founded penalty function

Assume that the penalty was fixed regardless of the magnitude of the violation. The figure belowt provides an illustration.



Explain how this figure demonstrates the problem of fixed penalties, i.e., penalties that are insensitive to the seriousness of the violation.

Answer: Given the fixed penalty S', there exists an "outside option" (= violate is profitable for $\Delta V > \Delta V'$). This implies that the effective penalty function is given by the red lines, and agents who satisfy $\Delta V > \Delta V'$, will always violate ==> the compliance rate is reduced.