

APPENDIX

This Appendix presents formal models and calculations in support of the accompanying text. Problem 1 is a simple model analysed using Decision Theory; Problems 2 and 3 include several models analysed using Non-cooperative Game Theory.

All payoffs are measured (in von Neumann-Morgenstern utilities) relative to the situation of legal behaviour by the state. In general, a state's relative value for undetected illegal action is denoted $+d$, and its relative value for detected illegal action is $-b$. Detection is always by attribute sampling — if inspected, illegal behaviour is detected with probability $1 - \beta$, and missed with probability β . In the case of legal behaviour, there is no possibility of apparent detection. In the models that include IAEA as a player (Problem 2 and 3), IAEA's relative utility for illegal behaviour by the state is $-a$ if detected and $-c$ if not. It is always assumed that

$$0 < a < c, \quad 0 < b, \quad 0 < d, \quad 0 < \beta < 1.$$

Problem 1

This problem refers to a state with one site, which is to be inspected for certain. IAEA is not modelled explicitly. The state's expected value is 0 for legal behaviour and

$$-b(1 - \beta) + d\beta$$

for illegal behaviour. The State is deterred from illegal behaviour if and only if

$$1 - \beta > \frac{d}{d + b} = \frac{1}{1 + (b/d)}. \quad (1.1)$$

A form equivalent to (1.1) and similar to other conditions for guaranteeing legal behaviour that will be obtained below is

$$\frac{d}{b + d} \cdot \frac{1}{1 - \beta} < 1. \quad (1.2)$$

Condition (1.1) prescribes the conditions under which inspection is sufficiently effective to guarantee compliance. As noted in the text, condition (1.1) relates a "technical" parameter — the detection probability, $1 - \beta$ — to a "political" parameter — the value ratio, b/d .

Detection probability can be understood as proportional to Inspection Effectiveness, as discussed in the text. The relationship of level of inspection resources, ε , to inspection