Robust Inspection for Invasive Species with a Limited Budget

L. Joe Moffitt, Ph.D.
Professor, Department of Resource Economics
University of Massachusetts, Amherst

PREISM Invasive Species Workshop
Washington D.C.
October 21, 2005

Acknowledgments

- John K. Stranlund, Barry C. Field, and Craig D. Osteen
- USDA/ERS/PREISM Cooperative Agreement No. 43-3AEM-4-80115
- Massachusetts Agricultural Experiment Station Project No. MAS00861

Publications

- L. J. Moffitt, J. K. Stranlund, B. C. Field, and C. D. Osteen, “Robust Inspection for Invasive Species with a Limited Budget,” in Alfons Oude Lansink (ed.), The Economics of Plant Health, Springer (in press).

- L. J. Moffitt, J. K. Stranlund, and B. C. Field, “Inspections to Avert Terrorism: Robustness Under Severe Uncertainty,” Journal of Homeland Security and Emergency Management (in press).

Overview

- I. Problem Statement
- II. Key Assumptions
- III. Approach
- IV. Model
- V. Example
- VI. Conclusions

I. Problem Statement

- An inspector wants to preclude entry of an invasive species.
- It’s not feasible to inspect everything.
- What inspection protocol should be used?

II. Key Assumptions

- 1. The probability of something being there to be found is uncertain (this is not a problem involving gambles with known probabilities).

- 2. The inspector is risk averse.

Decision Making under Uncertainty

- Maximin, Maximax
- Laplace; Hurwicz
- Katzner 1998; Horan et al. 2002
- Kelsey 1993

III. Approach: Info-Gap Decision Theory

- Probability distributions over rewards are not available.
- Seeks robustness - the largest possible range of uncertainty over which a performance requirement is met.
- Satisficing rewards, not optimizing.

Components of Info-Gap

- System Model: Rewards that follow from decisions and events.
- Performance Requirement: A reward level deemed necessary.
- Uncertainty Model: A set whose elements are realizations of uncertain events.
- Robustness Function: The greatest level of uncertainty under which the performance requirement is achieved.

IV. Model

- Represents inspection protocols as gambles with unknown probabilities.
- Uses stochastic dominance rules to compare protocols.
- Identifies most robust, dominant protocol.
- Solved as a simple mathematical programming problem.

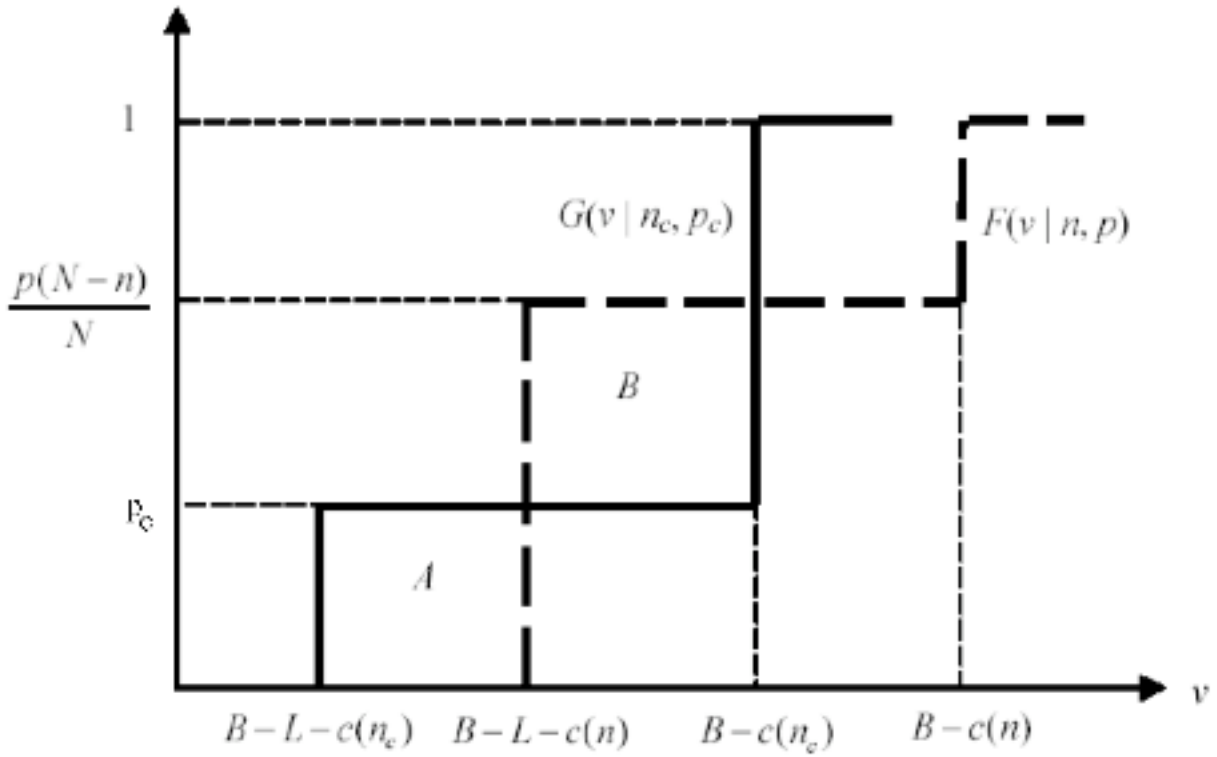
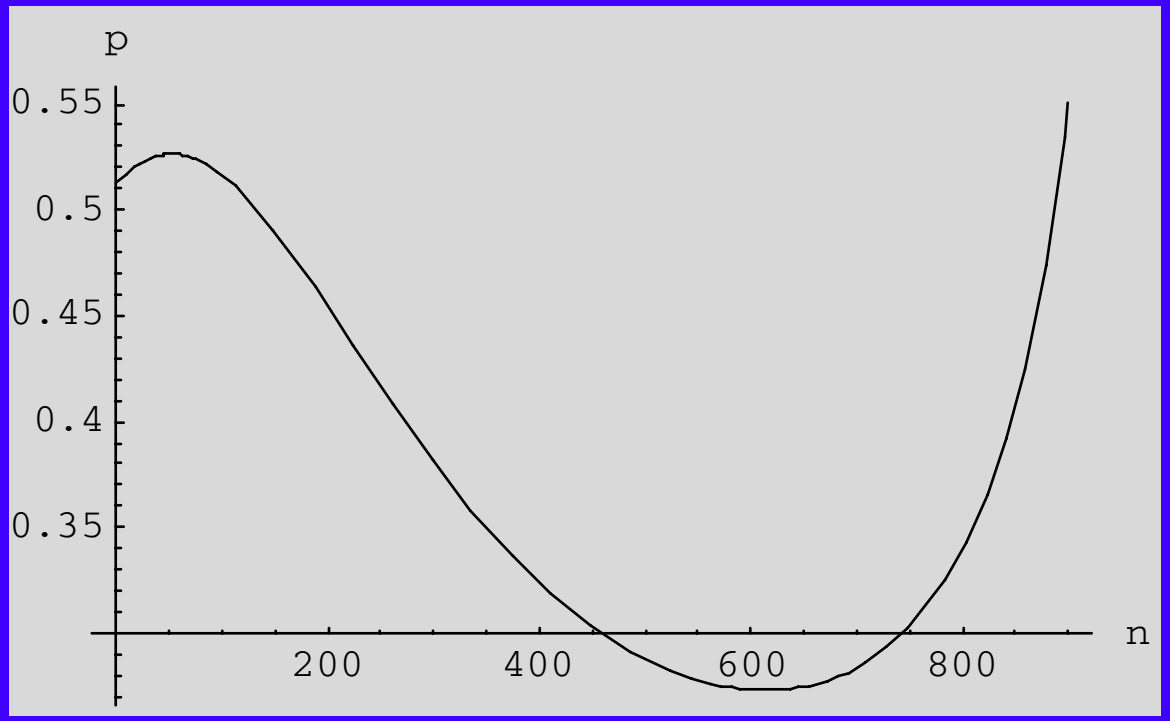


Figure 1: Depiction of the Stochastic Dominance Performance Requirement

IV. Example Robustness Function



Interpretation

- Vertical axis in the largest probability for which the performance requirement will be achieved.
- Robustness is not monotonic in inspection.
- Less may be more.

VI. Conclusions

- Info-gap approach offers a protocol for characterizing risk trade-offs despite ignorance of probabilities.
- Alternative decision making tool to conventional risk management.
- There could be a large range of inspections for which more inspections leave the inspector less secure.