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Economic Efficiency and Equity of Alternative Government Programs for Invasive Species: A Decision Model of Government Action

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Major Incentive for Modifying Invasive Species Management

1. *Ex post* Indemnification
2. *Ex Ante* Insurance
3. Multi-tiered
4. Mixed Programs

Literature Review

1. Shogren (2000):incorporating economics into risk reduction strategies for invasive species using a model of endogenous risk
2. Thomas and Randall (2000):the role information and revocability play in NIS management by focusing on intentional releases
3. Evans (2003)
4. Horan et al. (2002)
5. Elbakidze, Levan(2008)
6. Homans (2007)

Elbakidze and McCarl, 2006

The optimal level of investment in pre-event preparedness increases as:

- Disease spread rates gets larger
- Response strategy is less effective and more costly
- Increase probability of disease introduction
- A decline in the cost of pre-event preparedness activities
- Ancillary benefits of the strategy outside of an event increase.

Salient Features of Producer Decision Making w.r.t. Invasive Species Prevention & Management

1. varying probabilities of disease infestation,
2. differing efficacy of management practices to mitigate risk,
3. varying degrees of observability of those management practices in order to identify the appropriate government response to a potential outbreak.

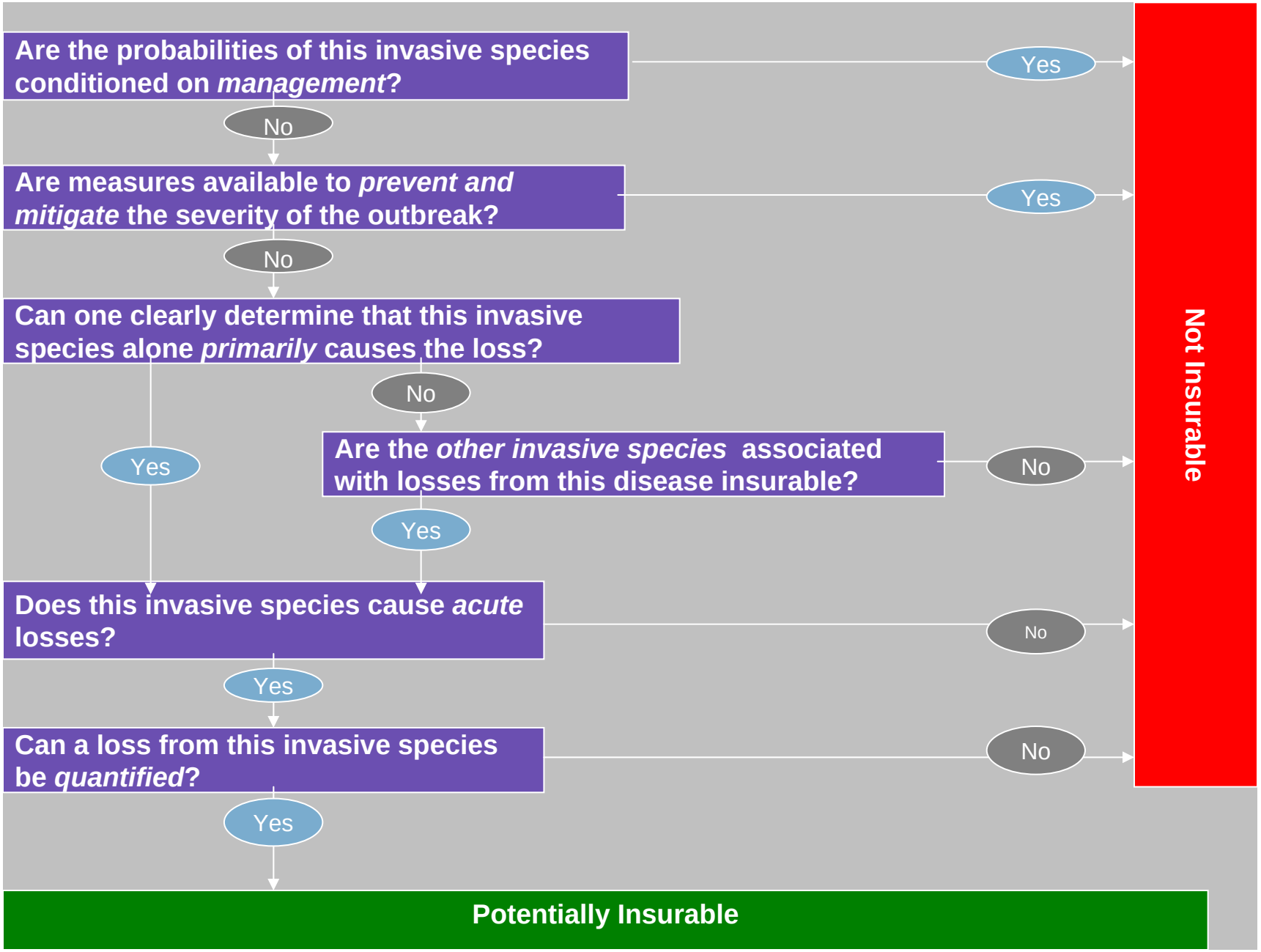
Ex Post Indemnification

1. Does not require significant *a priori* institutional infrastructure or producer enrollment.
2. Avoids the creation of institutions and program costs for a low probability event.
3. *Ex post* indemnification makes it difficult to either efficiently or equably indemnify rare events.
4. A completely *ad hoc* program also precludes incentive structures to induce preventive measures.
5. A related issue is the demand for protection for extremely low probability risks.
   - decision makers often make large errors in subjective assessments
   - insurance demand?
   - penalties and incentive structures (Bonus/Malus systems)?

Ex Ante Indemnification and Insurance

1. *Ex ante* insurance institutionalizes premiums and indemnity structures for insurable risks. More time is available to define and implement the program than an *ex post* program.
2. A standing program is costly and, if premiums are charged, government costs are reduced.
3. However, if producers are unwilling to pay for insurance, then government objectives are thwarted

   - generally, the low willingness to pay for insurance is a function of either low probabilities of occurrence or low economic costs of an occurrence, or both.


Are the probabilities of this invasive species conditioned on *management*?
Yes
No
Are measures available to *prevent and mitigate* the severity of the outbreak?
Yes
No
Can one clearly determine that this invasive species alone *primarily* causes the loss?
No
Yes
Are the *other invasive species* associated with losses from this disease insurable?
No
Yes
Does this invasive species cause *acute* losses?
No
Yes
Can a loss from this invasive species be *quantified*?
No
Yes
Not Insurable
Potentially Insurable

Ex Post Indemnity with Producer Choice of Preventive Measures

$$\underset{x}{Max} = (1-\delta)\left[\begin{array}{l}(1-\rho(x_0))U(W_0+PY-C-wx_0) \\ +\rho(x_0)U(W_0+PY-C-wx_0-L+(1-d)L)\end{array}\right]$$

$$+\delta\left[\begin{array}{l}(1-\rho(x_1))U(W_0+PY-C-wx_1) \\ +\rho(x_1)U(W_0+PY-C-wx_1-L+(1-d)L)\end{array}\right]$$

Ex ante insurance with producer choice of preventive measures

$$\underset{x}{Max} = (1-\delta)\left[\begin{array}{l}(1-\rho(x_0))U(W_0 + PY - C - wx_0 - PR(d) \\ +\rho(x_0)U(W_0 + PY - C - PR(d) - wx_0 - L + (1-d)L)\end{array}\right]$$

$$+\delta\left[\begin{array}{l}(1-\rho(x_1))U(W_0 + PY - C - wx_1 - PR(d) \\ +\rho(x_1)U(W_0 + PY - C - PR(d) - wx_1 - L + (1-d)L)\end{array}\right]$$

Ex Ante insurance with observable producer choice of preventive measures

$$\underset{x}{Max} = (1-\delta)\begin{bmatrix}(1-\rho(x_0))U(W_0+PY-C-wx_0-PR(d)\\ +\rho(x_0)U(W_0+PY-C-PR(d)-wx_0-L+(1-d)L)\end{bmatrix}$$

$$+\delta\begin{bmatrix}(1-\rho(x_1))U(W_0+PY-C-wx_1-PR(d)\\ +\rho(x_1)U(W_0+PY-C-PR(d)-wx_1-L+(1-d)L)\end{bmatrix}$$

Tiered Insurance without Complete Observability

$$
\begin{aligned}
\underset{x}{Max} = \delta & \left[\begin{array}{l} (1-\rho_1)U(W_0 + PY - F - C - wx_1 - PR(x_1)) \\ +\rho_1 U(W_0 + PY - F - C - wx_1 - PR(x_1) - L + (1-d(x_1))L) \end{array} \right] \\
+(1-\delta) & \left[\begin{array}{l} \gamma(1-\rho_0)U(W_0 + PY - F - C - wx_0 - PR(x_0)) \\ +\gamma\rho_0 U(W_0 + PY - F - C - wx_0 - PR(x_0) - L + (1-d(x_0))L) \\ +(1-\gamma)(1-\rho_0)U(W_0 + PY - F - C - wx_0 - PR(x_1)) \\ +(1-\gamma)\rho_0 U(W_0 + PY - F - C - wx_0 - PR(x_1) - L + (1-d(x_1))L) \end{array} \right]
\end{aligned}
$$

Case Study: H5 and H7 subtypes of low pathogenic avian influenza (AI) and Exotic Newcastle's disease (EN)

- Modeling
  - Further develop conceptual model and policy alternatives
- Data collection
  - Elicit subjective risk probabilities from experts regarding risk levels
  - Characterize the producer decision context
  - Quantify the efficacy of management to mitigate risk
- Behavioral Analysis Under:
  - Basic insurance and ad hoc indemnity programs
  - multi-tiered indemnification,
  - *ex post* validation of preventative measures,
  - combinations of indemnification programs combined with business interruption insurance
  - Others

Practices identified to mitigate AI and EN

- Avoid taking birds away from the premises and returning them during an AI outbreak.
- All flocks should be fenced or confined, in order to avoid contact with any wild birds, especially waterfowl.
- Introduce new stock only from sources known to be AI free and not from areas in or near an AI outbreak zone.

Practices identified to mitigate AI and EN

- Anyone on the site wears rubber boots, and wears them only on your own premises, to avoid ‘tracking in’ disease.
- All dead birds must be disposed of on the farm in a bio-secure manner.
- Eggs must be held on the premise until the farm is released from quarantine.
- Before another generation of chickens enters the farm wash and sanitize the chicken house.

Sample Probabilistic Questions

- Assuming the company and each production unit have done every measurement perfectly, how many AI outbreaks would you expect the company to incur on the 1,000 units during the next year?

- Assuming the company and each production unit have done all the measurements except “Avoid taking birds to (or bringing birds home) from the premises during an AI outbreak”, what is the probability of an out break for this company?

Sample Probabilistic Questions

- Consider typical industry practices what is the probability a company will consistently follow the practice “Avoid taking birds to (or bringing birds home) from the premises during an AI outbreak.” On a scale 0 to 100 (0 is no change at all and 100 is absolute certainty), what is the probability each practice will be followed consistently during the previous 12 months?
- If AI outbreaks in this company’s production unit and APHIS inspector want to investigate the reason. What is the probability the inspectors can accurately assess whether “Avoid taking birds to (or bringing birds home) from the premises during an AI outbreak”, was followed during the previous 12 months?

Sample Probabilistic Questions

- Assume APHIS was to randomly check ***10%/25%/50%*** of the 1000 units each ***month/year*** with an unannounced visit. Each of the 11 measures would be examined. If violations were observed the company would be fined $10,000. What is the probability the inspectors can accurately assess whether “Avoid taking birds to (or bringing birds home) from the premises during an AI outbreak”, was followed during the previous 12 months?

Where to from here?

- Collect subjective probability from avian disease experts
- Look at mixed programs
- Evaluate the effect of observability on these programs
- Consider the trade off between government oversight cost and mitigation of moral hazard behavior