Animal Health Economics

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Outline

• Introduction
• Economics to Consider
• Animal Production and Trade
• Empirical Research Examples
• Decision Optimization
• Final Discussion
Animal disease can be an...

- Animal health problem
- Human health problem
- Production problem
- Economic problem
Infectious Animal Diseases

- Almost 60 percent of known human pathogens are of animal origin (Woolhouse and Gaunt, 2007)

- On average, a new disease has emerged or re-emerged each year over the past several decades with 75 percent of these being zoonotic (King, 2004)

- Between 1940 and 2004, found that of 60 percent of EIDs in the United States were zoonotic, with 72 percent originating in wildlife (Jones et al., 2008)
Infectious Diseases

• Increasing disease prevalence driven by:
  – Agricultural and food systems
    • Spatial livestock production, mixed biosecurity, trade
  – Ecosystems
    • Land use and climate change
  – Human living environment
    • Population, standard of living, travel
Economic-Health Tradeoff

• As veterinarians, your prerogative is animal health
  – If there is a control measure, it should be used

• Producers decides optimal control based on:
  – Time
  – Cost
  – Effectiveness of treatment
Economic Assessments

Source: Pendell et al. (2014)
ECONOMICS OF ANIMAL AGRICULTURE
What is Economics?

• Simplest definition: The study of the allocation of scarce resources

• Animal health economics is concerned with allocation of resources to:
  – Inform disease prevention measures
  – Combat disease
  – Minimize disease impacts
Valuing Direct Costs

- Direct Costs: Costs directly accounted to the payer
  - Drug and vaccine costs
  - Labor costs
  - Disease control measure costs
Valuing Indirect Costs

• Indirect Costs: Costs not directly accounted to the payer
  – Supply chain impacts
  – Consumer price changes
  – Trade changes
  – Impacts on animal and human health
Who Pays These Costs?

- Producers
- Government: Local, State, and Federal
- Domestic Consumers
- International Consumers
Share of U.S. household consumer expenditures by major categories, 2014

- Housing: 33.3%
- Transportation: 17.0%
- Food: 12.6%
- Personal insurance, pensions: 10.7%
- Health care: 8.0%
- Entertainment, alcoholic beverages: 6.0%
- Apparel: 3.3%
- Savings: 3.3%
- Other: 3.3%
- Education: 2.5%

Note: “Other” includes personal care products, tobacco, and miscellaneous expenditures.
ANIMAL PRODUCTION AND TRADE
Proportion of Global Meat Production

Proportion of Global Meat Consumption

Global Annual Per Capita Meat Consumption

Source: OECD Per Capita Meat Consumption, 2016
U.S. Animal Production

- United States a net exporter
- Value of exports often exceed $100 billion per year
- Member of World Trade Organization (WTO)
  - Part of the sanitary and phytosanitary (SPS) agreement
  - Trade measures encouraged to use international standards
  - Further reading: Zepeda et al. (2005)
Market value of livestock, poultry, and their products sold in 2012

1 dot = $20 million

Source: USDA- World Agriculture Supply and Demand Estimates, 2016
EMPIRICAL EXAMPLES OF HIGHLY PATHOGENIC AVIAN INFLUENZA
Poultry Business Continuity

• Effect of business continuity on U.S. market

• Integrated epidemiological and economic model

• Model effects of a hypothetical highly pathogenic avian influenza (HPAI) outbreak
Business Continuity: Control Areas

Methodology Overview

Risk Assessment
Secure Egg Supply Plans

Epidemiological Model
InterSpread Plus

Economic Analysis
Partial Equilibrium model
Results

HPAI Disease Impacts in Minnesota (% Changes)

Shell Egg Price  Table Egg Price  Processed Egg Price  Production Table Eggs  Production Processed Eggs  Net Exports Table Eggs  Net Exports Processed Eggs  Demand Table Eggs  Demand Processed Eggs

Q1: Business Continuity  Q1: No Business Continuity  Q2: Business Continuity  Q2: No Business Continuity
Results: Welfare

Welfare Impacts of HPAI Outbreak for Minnesota ('000)

<table>
<thead>
<tr>
<th>Total Producer Surplus Change</th>
<th>Consumer Surplus Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1: Business Continuity</td>
<td>Q1: No Business Continuity</td>
</tr>
<tr>
<td>Q2: Business Continuity</td>
<td>Q2: No Business Continuity</td>
</tr>
</tbody>
</table>

The bar chart illustrates the welfare impacts of HPAI outbreaks for Minnesota, measured in millions of U.S. dollars, with a focus on total producer surplus and consumer surplus changes. The chart distinguishes between Q1 (Business Continuity) and Q2 (No Business Continuity) scenarios, with implications for increased losses due to the disease.
Highly Pathogenic Avian Influenza

- **211 Commercial Flocks**
- **21 Backyard Flocks**
- **49,700,000 Birds Affected**
- **6/17/15 Last Detection Reported**
Poultry Trade Example

• 2014-2015 HPAI in U.S. poultry

• Changes in trade composition and quantity

• Regionalized importer trade response
  – Disease status had to be established for all regions
  – Control program to be in places
  – National and state level coordination
## Results

<table>
<thead>
<tr>
<th>Aggregated Products Aggregated Ban</th>
<th>Aggregated Products Types of Bans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate Poultry Trade Ban</td>
<td>-99.37***</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
</tr>
<tr>
<td>National Poultry Trade Ban</td>
<td>-100.00***</td>
</tr>
<tr>
<td></td>
<td>(0.16)</td>
</tr>
<tr>
<td>State Poultry Trade Ban</td>
<td>-34.95***</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
</tr>
<tr>
<td>Country Poultry Trade Ban</td>
<td>16.18</td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
</tr>
</tbody>
</table>

Observations 13,380 13,380  
Number of ID 345 345  

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
DECISION OPTIMIZATION
Economic Concepts in Decision Making

• Opportunity Costs
  – The forgone value of the choice(s) not taken

• Marginal Benefits/Costs
  – Benefits/costs associated with an additional unit of activity or good

• Understanding Value of Money
  – Discounting future revenue/costs to present day worth
Reactive vs. Proactive Approaches

**Reactive**
“Find a Cure”

**Proactive**
“Prevention”

<table>
<thead>
<tr>
<th>Investment in Prevention</th>
<th>Costs of an Outbreak</th>
</tr>
</thead>
<tbody>
<tr>
<td>$</td>
<td>$</td>
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</table>

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Net Present Value (NPV)

- Estimating the present value today of some future amount accounting for the discount rate \( r \)

\[
NPV = \frac{\text{Future Value}}{(1+r)^t}
\]

Example:

Future cost of a disease at time \( T = $1,000 \)
Discount rate: \( r = 4\% \)
Time \( T = 3 \) years

\[
NPV = \frac{$1,000}{(1.04)^3} = $889
\]

The present cost of a future disease is $889 in this example.
Methods for Decision Optimization

• Cost-minimization analysis
• Cost-benefit analysis
• Cost-effectiveness analysis
• Cost-utility analysis
Cost-Minimization Analysis

• Only compare direct monetary costs associated with decisions
• Choose the minimum cost alternative

Minimize $C - MB$

Where: $C$ = Decision costs
       $MB$ = Decision Monetary Benefits
Cost-Benefit Analysis (CBA)

• Uses benefit-cost ratio that expresses the monetary benefits of a decision to the costs of that decision

  – Value of animals not infected due to vaccination
  – Value of farm production due to disease avoidance

• Choose the highest benefit-cost ratio

  \[
  \text{Maximize BC Ratio} = \frac{MB}{C}
  \]

Where:
\[C = \text{Costs of decision}\]
\[MB = \text{Monetary Benefits}\]
Cost-Effectiveness Analysis (CEA)

- Uses cost-effectiveness ratio that expresses the non-monetary health benefits of a decision
  - # of infected animals
  - # of days farm not in production

- Used in fields where not appropriate to monetize benefit
  - E.g., value of life or quality of life
Cost-Effectiveness Analysis (CEA)

- Use CE Ratio to compare alternative decisions

\[ \text{CE Ratio} = \frac{C}{NMB} \]

Where:
- \( C \) = Costs of Decision
- \( NMB \) = Non-Monetary Benefits
CEA Tradeoff Grid

- Quadrant IV: Dominated
- Quadrant I: Tradeoff
- Quadrant III: Tradeoff
- Quadrant II: Dominant

Cost Differences (+)

Effect Differences (–)

Cost Differences (–)
Cost-Utility Analysis (CUA)

• Uses cost-utility ratio that expresses the benefits as weighted utility (QALY) of a decision

• Special case of CEA, but includes societal preferences

• Used in health technology assessments

• Quality- adjusted life years (QALY)
  \[ = \text{Time in health state} \times \text{Utility} \]

• Where utility is person specific: Perfect Health =1; Death =0
Cost-Utility Analysis (CUA) Cont.

• Like CEA use grid to compare CU ratios

\[
\text{CU Ratio} = \frac{C}{NMB}
\]

Where:
- \( C \) = Costs of Decision
- \( NMB \) = Non-Monetary Benefits
FINAL RECAP
Recap

• Animal diseases can have great negative economic impact

• Trade is an important component of U.S. production

• Producers make decisions based on a myriad of factors, which should be considered

• CBA, CEA, and CUA are all tools that can be used in decision making
Thank you for your attention.
Are there any questions?

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References


