Economic Impacts of FMD on North America and Australia

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Overview

• Motivation

• Objectives

• Models

• Results

• Discussion

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Motivation

• Invasive species in livestock pose a serious threat to agriculture, human health, and the economy.
  ▪ The UK livestock industry has suffered large losses due to FMD outbreaks (most recent cases in 2007).
  ▪ A single mad cow (BSE) found in Alberta in 2003 cost Canada $25 million per day (FSB News, 2003).
  ▪ In 2003, the U.S. lost about $3-5 billion in exports because a single incident of mad cow disease in Washington State.

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Motivation

• Invasive species policies and impacts differ across the world given cultural, socio-economic, political and spatial diversity. For example,
  - U.S. has contiguous neighbors (Canada & Mexico), large domestic population, feedlot driven beef production, exports about 7% of production.
  - Australia is a large island country, domestic population about the size of New York, 80% grass fed, exports about 65% of production, also large exporter of live cattle.
Motivation

• (cont.)
  ▪ Canada, smaller domestic population, feedlot driven beef production, exports about 44% of production.

  ▪ Mexico, larger domestic population, lower income, 65% grass fed, 35% feedlot production (northern part of the country), some live exports.
Objectives

• *Project:* Provide estimates of welfare measures focusing on invasive species (hypothetical FMD) outbreaks in livestock sectors for North America (U.S., Canada & Mexico) and Australia.

• Compare FMD outbreaks for beef cattle across countries
  - Decentralized model for each country
## Summary Statistics

<table>
<thead>
<tr>
<th>Population</th>
<th>Per Capita GDP</th>
<th>Beef and Veal Summary - 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(million)</td>
<td>Production</td>
</tr>
<tr>
<td></td>
<td>US dollars</td>
<td>(1000 metric tons)</td>
</tr>
<tr>
<td>Australia</td>
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<td>20880</td>
</tr>
<tr>
<td>Canada</td>
<td>31.3</td>
<td>23621</td>
</tr>
<tr>
<td>Mexico</td>
<td>100.3</td>
<td>5823</td>
</tr>
<tr>
<td>United States</td>
<td>281.4</td>
<td>34280</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Population</th>
<th>Per Capita GDP</th>
<th>Beef and Veal Summary - 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(million)</td>
<td>Production</td>
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<tr>
<td></td>
<td>US dollars</td>
<td>(1000 metric tons)</td>
</tr>
<tr>
<td>Australia</td>
<td>21.3</td>
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<tr>
<td>Canada</td>
<td>33.3</td>
<td>45033</td>
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<tr>
<td>Mexico</td>
<td>107.7</td>
<td>10103</td>
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<tr>
<td>United States</td>
<td>304.5</td>
<td>47427</td>
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</tbody>
</table>
Why FMD?

• Highly contagious with severe productivity, food security, and trade implications

• Outbreaks reported in 52 countries since 2000

• 70 countries recognized as FMD free (more than 100 countries not recognized as FMD free by OIE)

• Last reported FMD outbreak in study countries
  - Australia - 1872
  - Canada - 1952
  - Mexico - 1954
  - U.S. - 1929

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Reported FMD Outbreaks 2005 - 2009

Cattle
Theoretical Model

• Assume a representative producer maximizes an infinite stream of discounted expected profits subject to age specific stock dynamics and other production constraints (Jarvis; Aadland).

• Representative producer chooses the number of cull cows, imports, exports to max expected profit.

• Linked to a partial equilibrium framework, and assuming perfectly competitive markets, products are sold on the domestic market, as well as imported and exported (Zhao, Wahl, and Marsh).
Empirical Model

• Specified as a deterministic, discrete time optimal control model to account for intertemporal nature of livestock inventories and invasive species.

• Allows nested time steps: production/marketing decisions (annual) and FMD spread (weekly).

• Systematically link economic decisions on breeding inventories to live or feeder cattle, retail, and import & export markets.

• Calculate welfare impacts from hypothetical FMD outbreak.

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Empirical Models

• Extensions from previous work
  • Price expectations
  • Disposal and indemnification costs
  • Live cattle trade
  • Feedlot and/or pasture systems
• Programmed in GAMS
Example Model

Breeding
- Breeding (Mature Female)
  - Offspring (M)
  - Offspring (F)
  - Culling
  - Culled Feeders
  - Culled Mature Females
- Culled Cow Supply
- Culled Cow Market
- Culled Cow Demand
  - Slaughter/Packing
    - Fed Beef Supply
    - Cow Beef Supply
    - Foreign Beef Supply
    - Wholesale/Retail Market
      - Domestic Demand
      - Export Demand

Breeding Cow Imports/Exports

Feeder Supply
- Retention
  - Feeder Market
  - Feeder Demand
    - Finishing
      - Fed Cattle Supply
        - Grass Fed & Feedlot
        - Fed Cattle Market
          - Export Demand
            - Export Demand

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Model Data & Assumptions

- Historical production, feeding & slaughter parameters, and data from respective government agencies, published research, or estimated values.
- Consider a FMD outbreak with export market bans imposed for 3 yrs and decrease 5% domestic demand.
- Calibrate the U.S., Canadian, Mexican, & Australian models to 2000 inventories, market prices/quantities, etc.
FMD Assumptions

• Standard S-I-R type model
  • States
    • susceptible
    • latent infectious (first week), second week infectious, third week infectious
    • immune (recovered or vaccinated)
    • removed (dead or depopulated)
  • Parameters from Schoenbaum and Disney (2003) and others.

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Country Specific Characteristics

- Australia
  - 80% fed cattle on pasture
  - 20% in feedlot
  - Price grid constructed for WA
  - Live cattle exports
  - No cattle imports
Country Specific Characteristics

- For Mexico
  - 65% fed cattle on pasture (south)
  - 35% in feedlot (north)
  - Live cattle exports
### Depopulation Scenarios

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Depop Rate</th>
<th>Australia</th>
<th>Canada</th>
<th>Mexico</th>
<th>United States</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50%</td>
<td>-7.37</td>
<td>-14.48</td>
<td>-16.79</td>
<td>-91.89</td>
</tr>
<tr>
<td>2</td>
<td>60%</td>
<td>-5.12</td>
<td>-12.20</td>
<td>-8.95</td>
<td>-59.54</td>
</tr>
<tr>
<td>3</td>
<td>70%</td>
<td>-3.32</td>
<td>-9.88</td>
<td>-5.91</td>
<td>-40.75</td>
</tr>
<tr>
<td>4</td>
<td>80%</td>
<td>-1.88</td>
<td>-8.16</td>
<td>-4.24</td>
<td>-29.12</td>
</tr>
<tr>
<td>5</td>
<td>90%</td>
<td>-0.75</td>
<td>-6.43</td>
<td>-3.30</td>
<td>-21.53</td>
</tr>
</tbody>
</table>

* Preliminary estimates based on depopulating latent infected stock.
Price Response

FMD Scenario 2

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Australia
Price Response

FMD Scenario 2

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Discussion Points

• Economic impacts vary by country
  ▪ Mexico, U.S.
  ▪ Australia, Canada

• Alternative Tactics
  ▪ Depopulation
  ▪ Vaccination
  ▪ Joint
Discussion Points

• Model runs dependent upon historical parameters and assumptions.

• Circumstances may require region specific adjustment to production management and technologies (birth, calving, weaning rates).
Future Research

• Role of compensation costs and payments in model.

• More regionalization and cooperative policies.

• Multiple species, as well as wild life.

• Impacts on lower income countries (food security, draft animal productivity).

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Questions/Comments?
Selected References


