Economic impacts for alternate depopulation capacities for a FMD outbreak in the U.S.[1]

Introduction

Contagious foreign animal diseases cause substantial economic harm, especially for countries whose livestock and meat sectors are dependent on export markets. Minimizing impacts of a contagious foreign animal disease outbreak is an important purpose of an animal health management plan. Disease prevention is a top priority of animal health officials, though impossible to ensure. Heightened bioterrorism threats together with increased globalization and world travel make transmission of foreign animal diseases more probable. The ultimate economic impact of a disease outbreak is conditional on the disease management plan enacted. Consequently, it is critically important to develop and assess both epidemiological and economic implications of alternative control strategies if a contagious livestock disease

There are two main objectives in this study. First, this research estimates impacts of implementing four alternative animal depopulation strategies in the case of a hypothetical FMD outbreak in the United States. Second, this study quantifies both the expected economic impacts as well as the probability distributions of expected economic impacts associated with various emergency animal depopulation strategies. Results reveal economic impacts of selected FMD management plans that are important for policy makers, government regulatory and research agencies (e.g., USDA's Animal and Plant Health Inspection Service (APHIS) and Economic Research Service and the Department of Homeland Security), state and local animal health departments, academic scientists, and the livestock and meat industry. In the presence of risk and uncertainty, understanding probabilities of possible outcomes is integral as disease mitigation plans are designed.

Methodology

The epidemiological disease spread model used in this study is the North American Animal Disease Spread Model (NAADSM) which was originally developed by the USDA APHIS. Harvey et al. (2007) provides a detailed analysis of NAADSM.

This research evaluates FMD spread under four independent animal depopulation control strategies. The four alternate depopulation scenarios are: 1) depopulate known infected herds only (*Known Infected*), 2) depopulate known infected herds and herds that come in direct contact with known infected herds (*Known Infected & Direct Contact*), 3) depopulate known infected herds and all herds within a 1 km ring around known infected herds (*Known Infected & Ring*), and 4) depopulate known infected herds, herds that come in direct contact with known infected herds, and herds within a 1 km ring around known infected herds (*Known Infected, Direct Contact, & Ring*). In all four depopulation scenarios, a centrally-originating FMD outbreak is hypothetically introduced into a single feedlot in southwest Kansas. For each scenario, NAADSM is simulated with 1,000 iterations to create a distribution of probable disease spreads and durations. Both the expected value and the entire distribution of information (i.e., number of animals destroyed) for each scenario is incorporated our economic framework.

Outcomes from the epidemiological model are used in an economic model to determine the economic impact of the control strategies. The economic structural model consists of a set of

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demand and supply equations with horizontal and vertical linkages between different marketing levels.

An economic model was developed of the United States beef, pork, and poultry industries consisting of four marketing levels for beef within the farm-retail marketing chain, three marketing levels for pork, and two levels for poultry. International trade is integrated into the model because one of the main concerns in the event of an FMD outbreak would be its associated impact on U.S. meat product exports. For a description of the economic model see Pendell (2006).[2]

Results

The average number of animals that would be stamped-out if an FMD outbreak occurs is similar by scenario. The average *Known Infected & Direct Contact* scenario stamps-out the smallest number of animals, 1.75 million head, compared to the *Known Infected, Direct Contact & Ring*; *Known Infected & Ring*; and *Known Infected* which remove 1.78, 1.82, and 1.83 million head, respectively. Similar to the number of animals destroyed, the average lengths of outbreaks were 125, 124, 124, and 121 days for the *Known Infected*; *Known Infected, Direct Contact, & Ring*; *Known Infected & Ring*; and *Known Infected & Direct Contact*, respectively.

The standard deviation of the number of animals destroyed is large compared to the means. The variation for the number of animals destroyed in cattle feedlots across the different depopulation strategies range from 24 to 27%. Variation for cow-calf, dairy, and swine across the different scenarios range from 38 to 45%, 40 to 48%, and 262 to 290%, respectively. Large variation is a result of some simulations in which the number of animals destroyed was near zero and in others most of the animals in the region are destroyed because of direct and indirect contacts. Because standard deviations of animal depopulations are large, we investigate the economic implications of distributions of disease impact and spread.

Because all four depopulations strategies have similar output values (including the shapes of the distributions) only the *Known Infected* strategy results are discussed. The histogram of swine destroyed demonstrates why the standard deviations are large (Figure 1). For example, in 80% of the simulations there were zero swine destroyed while 9% of the simulations there were more than 795,000 head of swine stamped-out. More than 90% of the swine in this region are owned/managed by a single firm so direct and indirect contact rates are much lower than in cattle. However, with this concentration of ownership and hog production density, if one animal in the herd in exposed to FMD, the result is a high probability of spreading through the entire operation. As seen in the economic results discussed below, the distribution of epidemiological results has significant impacts on the economic welfare measures.

The discounted present value of producer surplus losses for the beef industry ranges from $1,894 million to $2,000 million. The pork and poultry industries also have producer surplus losses ranging from $159 to $177 million for pork and $0.42 to $0.55 million for poultry.[3] Beef consumer surplus declines by a small amount while pork and poultry industries see small gains.

[2] Pendell, D.L. "Value of Animal Traceability Systems in Managing a Foot-and-Mouth Disease Outbreak in Southwest Kansas." Ph.D. dissertation, Dept. of Agr. Econ., Kansas State University, September 2006.

[3] We assume no change in domestic demand for beef, pork, and poultry and a 100% first-year and 25% second-year decrease in export demand for beef and pork following a hypothetical FMD outbreak.

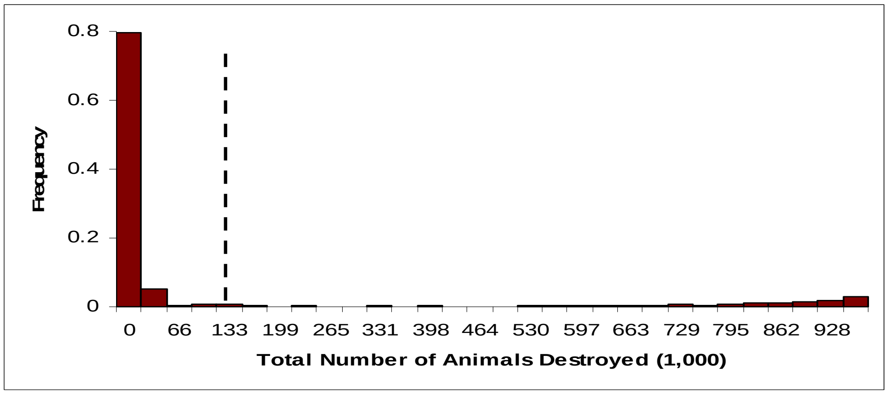
Figure 2 presents the distribution of the cumulative present value of 10-year total changes in producer welfare for the *Known Infected* scenario. The distribution of changes in producer surplus for the meat industry is bimodal reflecting the epidemiological distribution results. In 20% of the simulations, losses in producer surplus were between $2,667 million and $2,711 million (Figure 2). In the other 80% of the simulations, the producer surplus losses were much less with a range of $1,836 million to $1,923 million. Distributions of changes in producer surplus in pork are driving the bimodal shaped distribution of changes in total meat industry producer surplus. In Figure 3 (pork producer surplus), 20% of the simulations suggest the producer surplus losses would exceed $820 million while the remaining 80% of the time the producer surplus gains $0.32 million.

Conclusions

Concerns regarding potential outbreaks in the United States of foreign animal diseases have escalated substantially in recent years. The epidemiological results indicate the average numbers of animals stamped-out across the depopulation scenarios are similar. However, there is additional useful information that is provided by the distributions that is not found in the expected value. In the epidemiological results for swine, there are zero swine destroyed 80% of the time, compared to more than 795,000 head of swine stamped-out 9% of the time. This has significant implications in the economic impacts.

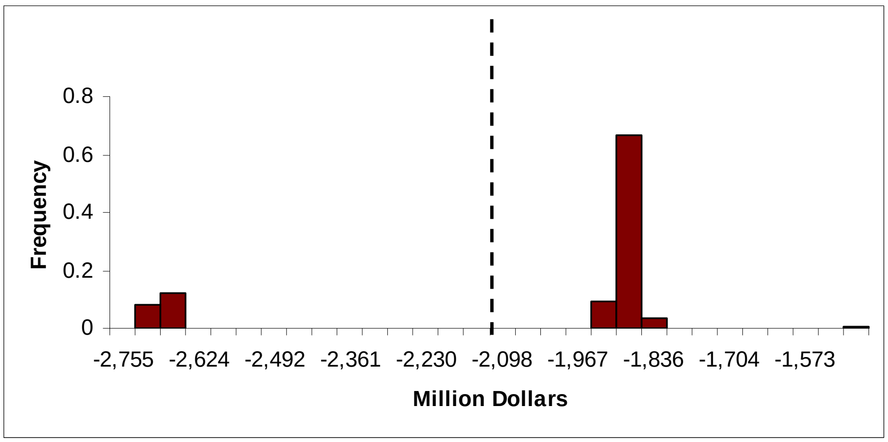
The economic results indicate on average the producer surplus losses are a little over $2,000 million for all four depopulation scenarios. Consumer surplus gains, on average, approximately $2 million in each of the four strategies. Incorporating the distributions of epidemiological results into the economic displacement model, the distributions of producer welfare impacts is bimodal shaped. Because over 90% of the swine in the region are owned/managed by a single firm, there is little direct and indirect contact outside the firm (i.e., there is little direct contact between swine and cattle in this region and there little indirect contact because the firm has its own feed-trucks, etc.). With little direct and indirect contact, the chances of FMD infecting in the swine population are significantly reduced. If FMD infects the swine population in this region (i.e., 20% of the time), a significant amount of swine are destroyed, which has significant implications on the economic impacts. If the swine become infected with FMD, the producer surplus losses are significantly larger by an additional $650 to $800 million. This suggests that there is a strong incentive to increase biosecurity measures to keep FMD out of the swine population in southwest Kansas.

Figure 1. Total Number of Swine Destroyed, Known Infected Scenario[a]



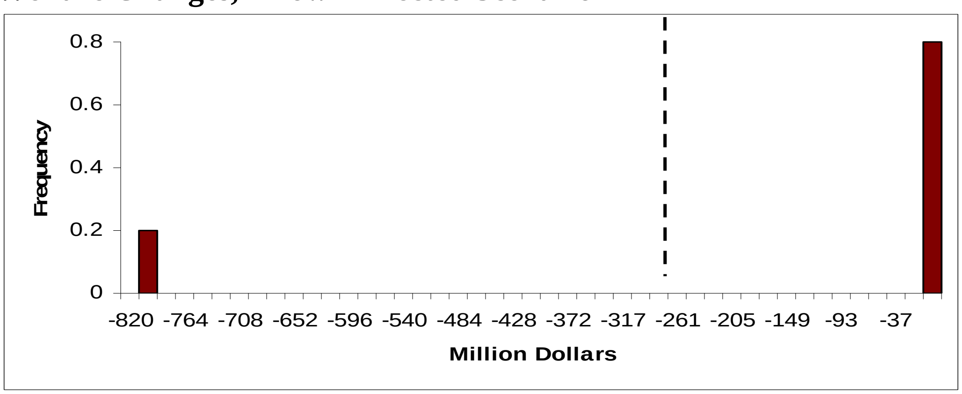
[a]Mean value is indicated with a dashed vertical line.

Figure 2. Cumulative Present Value of 10-YR Total Producer Welfare Changes, Known Infected Scenario[a]



[a]Mean value is indicated with a dashed vertical line.

Figure 3. Cumulative Present Value of 10-YR Total Pork Producer Welfare Changes, Known Infected Scenario[a]



[a]Mean value is indicated with a dashed vertical line.