Invasive Species Outbreaks and International Trade

Abstract

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Foot-and-Mouth Disease (FMD) is a vesicular disease that affects all cloven-hoofed animals caused by a virus that spreads through air, contaminated meat, and animal contacts. Due to its highly contagious nature, it is considered to be the most devastating livestock disease. Its outbreaks result in a loss of export markets by an infected country and present significant containment and eradication costs. Governmental agencies provide inspection and quarantine services prior to outbreak (*ex ante*) to prevent the introduction of the disease across national borders and enforces eradication policies following an outbreak (*ex post*). This research presents two models to analyze both *ex ante* and *ex post* decisions of FMD control, and an empirical application to the data on FMD outbreaks of the information theoretic estimators.

The first paper presents how location, spatial spillover effects, trade, and different control incentives across borders might prevent complete eradication of FMD outbreaks and undermine the potential success of disease control programs. Border inspection is crucial to protect the domestic livestock industry against incursion of the disease. A spatial game theoretic framework is applied to compare disease control strategies chosen under centralized and decentralized decision models for a cluster of spatially adjacent countries. The results show that spatial spillover effects are ignored and socially inferior control strategies are chosen under decentralized decision model. The probability of outbreak is smaller and the socially optimal levels of control effort and expected payoffs are greater under centralized decision model. Intervention might be required to change individual payoffs to incorporate spatial interactions and efficiently mitigate FMD outbreaks.

The second paper evaluates alternative mitigation measures following an outbreak in a stochastic optimal control bioeconomic-epidemiological model under uncertainty of a potential entry and spread of the disease. The conceptual model captures the intertemporal welfare impacts of mitigation measures and integrates dynamic livestock production,

disease dissemination, domestic consumption, and international trade. The model is applied to the case of a hypothetical outbreak in Canada. Since Canada exports around 50% of its beef production, a potential outbreak is a major policy concern. The mitigation scenarios including stamping-out, movement controls, and pre-emptive slaughter are evaluated. Results show that, under stamping-out and movement controls mitigation measures, as the level of pre-emptive slaughter increases from 30% to 90% of latent infectious cattle, the total welfare loss from an outbreak decreases from $171 billion to $16 billion.

The third paper proposes a generalized information theoretic estimator for the regression model with the first order spatial autoregression in the dependent variable. Extensive Monte Carlo experiments are used to compare finite sample performance of traditional and three information theoretic estimators including maximum empirical likelihood, maximum empirical exponential likelihood, and maximum log Euclidean likelihood. Finite sample performance of Wald, Likelihood ratio, and Lagrange multiplier tests constructed from these estimators is examined. It is found that information theoretic estimators are robust to specification of spatial autocorrelation and outperform traditional estimators in finite samples. Finally, the estimators are applied to an illustrative example of FMD outbreaks.