Managing Biological Pollution with Trade Flows in Mind: An Endogenous Ecological-Economic Geography

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INTRODUCTION

Invasive species and pathogens are forms of biological pollution that are increasingly transported via the long-distance exchange of goods (trade). Policies designed to interrupt these flows from risky exporters (e.g., surveillance measures) are generally evaluated based on whether they effectively prevent introductions into a particular region. However, a single-region focus ignores potentially complex behavioral responses arising across the broader landscape that can affect future risks.

An endogenous ecological-economic geography. The movement of species and pathogens within a localized region is largely based on the physical geography of that region. Trade connects dis-contiguous areas to define an economic geography. This means that the movement of species and pathogens over a broader landscape is based on an endogenous ecological-economic geography. The ecological-economic geography is endogenous because importers respond to ecological risks via altered trade flows and investment patterns, which in turn affect ecological risks. These effects are further influenced by endogenous changes in relative prices, arising due to public and private behavioral responses to ecological risks.

OBJECTIVES

We explore how importer responses to private biological risks can alter trade flows into a region, and also across regions as a result of risk and price feedbacks, along with regional changes in the scale of production. Additionally, we explore how policy tools such as surveillance efforts might be allocated efficiently across the landscape to account for risks and associated feedbacks. In particular, we illustrate how policies that help one region may affect others, with long-run implications for how the entire ecological-economic pattern of risks evolves.

Our particular application involves a numerical simulation of cattle trade within the United States. Two types of diseases are examined to explore the role of epidemiological characteristics: a slow-moving disease such as bovine tuberculosis (bTB), and a fast-moving disease such as foot and mouth disease (FMD).

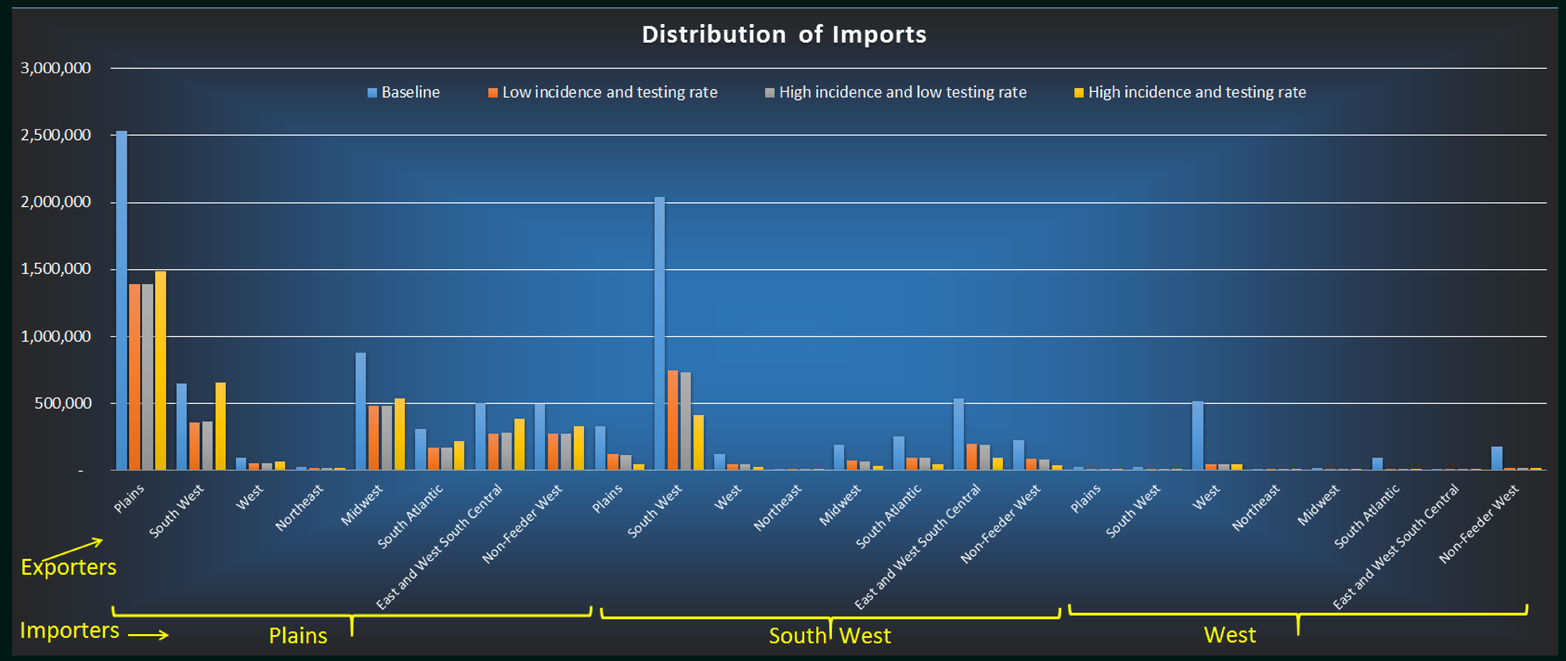
MODEL

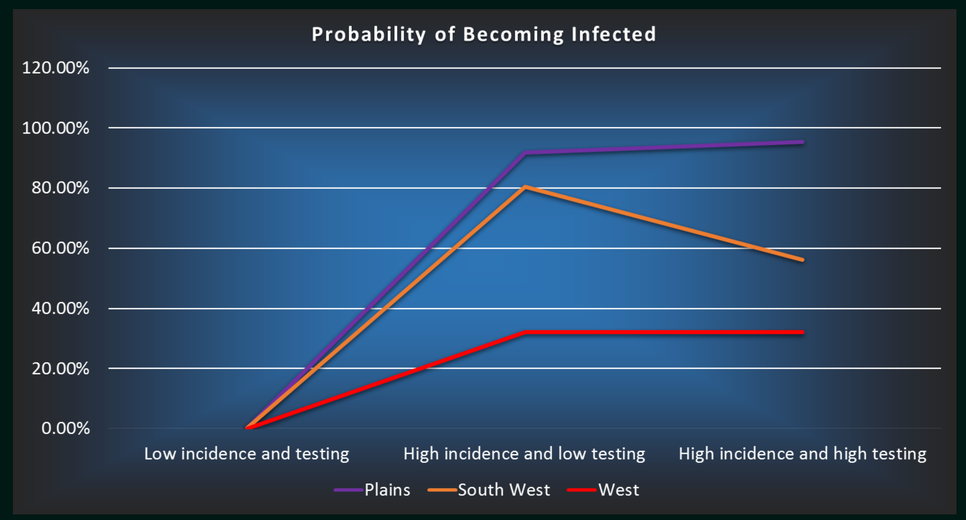
We develop a regional model of (beef) cattle production involving three production regions that each import young cattle from eight exporting regions. The importing regions account for more than 85% of all purchases of live domestic beef cattle in the United States. Producers are risk-neutral and operate in competitive input and output markets, and are risk-neutral. Cattle import prices are endogenous, as is the output price and local land prices.

Infection risks may be associated with imports from some cattle exporters. Publicly-managed surveillance occurs randomly both at time of export and at slaughterhouses. An importer whose herd becomes infected and detected receives a lower sales price (a salvage value) in the current period and in future periods until certified as non-infected. Also, once a herd is infected, the disease can spread locally in future periods, placing neighboring producers at risk.

Our spatial simulation model is calibrated based on cattle movement data constructed from electronic certificates of veterinary inspection obtained at the county level, and on NASS and ERS economic and production data. Our initial simulations involve fixed testing rates and fixed incidence rates.

RESULTS (Preliminary)





CONCLUSIONS

- The most efficient production occurs in the Plains, and the least in the West.
- Production falls significantly in each region with a low incidence disease. Probabilities of infection remain low due to reduced imports.
- Production is relatively unchanged in each region when moving to a high incidence disease, provided testing remains at low levels because the chance of being detected remains small (even though the probability of infection increases).
- Production in all but the Plains region falls with high incidence and a high testing rate. Reduced production in the South West causes the probability of being infected to fall in this region.
- Production is increased in the Plains in the final scenario, due to higher prices stemming from reduced production in the other regions. This is true even though the probability of being caught it high, as the higher price leads to higher salvage values.

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