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The impact of diseases on international beef trade: Market switching and persistent effects

Mike Webb, John Gibson*, Anna Strutt

Department of Economics, University of Waikato, Hamilton, New Zealand

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ABSTRACT

We quantify effects of disease outbreaks on agricultural trade with a gravity model of impacts of foot and mouth disease (FMD) and bovine spongiform encephalopathy (BSE) on beef trade. We account for official FMD status and for the impact of recent disease outbreaks. During and after a FMD outbreak, exporting countries substitute away from markets recognized as FMD-free toward lower value markets not recognized as FMD-free. Similarly, a country that has experienced BSE will export less to markets that have not experienced BSE and more to markets that have. Regaining official recognition of FMD-free status may aid recovery but does not negate the effects of a recent FMD outbreak. Models of FMD impacts should incorporate these market-switching effects, while analysis of FMD outbreaks should not focus solely on the loss of markets but rather should incorporate our finding that these loses are somewhat mitigated by market substitution. For countries not free of FMD, if the disease were to be eradicated an exporter should eventually be able to substitute towards higher value FMD-free markets. The value of this change in export market profile should be counted when considering the benefits of FMD eradication programs.

1. Introduction

Animal disease outbreaks, particularly foot and mouth disease (FMD) and bovine spongiform encephalopathy (BSE), may have severe economic consequences for international beef trade.[1] With global exports valued at US$40 billion in 2015, beef is a large contributor to world agriculture trade and so understanding the effects of diseases on beef trade is an important food policy concern. The salience of this issue for exporting countries is increased by the fact that the effects of a disease outbreak on market access may persist long after the outbreak has ended. For example, the full United States ban on Canadian beef imports after a 2003 BSE outbreak in Alberta lasted only four months, but the border opened only partially thereafter and it took four more years to end all restrictions on Canadian beef imports. Thus, as noted by Jones and Davidson (2014), the policy concern with animal disease outbreaks may quickly shift from issues of food safety to issues of market access.

These market access issues may not be well understood in the literature. Trade barriers that importers erect in response to a disease outbreak may force exporters to switch to lower value markets, such as those not FMD-free, so costs of the outbreak may exceed what is shown by studies that focus just on the immediate trade impact. If exports by other countries rise to fill the gaps left by a traditional exporter whose market access is affected by a disease outbreak, it may take several years for the disease-affected exporter to regain market share in higher value markets after the outbreak is over. It may take even longer for a country to be officially recognized as disease-free and this lack of recognition may further hinder market access.

These multiple and time-varying effects on market access may confound studies of how animal disease outbreaks affect international food trade. For example, Yang et al. (2013) use a gravity model to show that a FMD outbreak reduces exports during the period of the outbreak, with the impact possibly varying with whether a vaccination or slaughter policy is in place. This research does not, however, consider differences in response when the importer has FMD, whether there are persistent effects of the outbreak on trade, or whether official recognition of disease-free status reduces trade impacts. A similar possible understatement of long run effects on market access may be present in scenarios provided by Tozer and Marsh (2012) of a hypothetical FMD outbreak in Australia (the second largest beef exporter in the world). Some scenarios assumed that it would take just one year for beef prices to return to baseline levels after implementation of FMD mitigation

* Corresponding author at: Department of Economics, Private Bag 3105, University of Waikato, Hamilton 3240, New Zealand.
E-mail address: jkgibson@waikato.ac.nz (J. Gibson).

[1] See, for example, Lloyd et al. (2006) and Wieck and Holland (2010) on BSE and Knight-Jones and Rushton (2013) and Kompas et al. (2015) for useful surveys on FMD. Estimates of the value of trade are based on UN Comtrade data used throughout this article.

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measures. This assumption of a relatively quick recovery differs from what we find in the current study, which is that disease outbreaks affect trade for several years after they are contained.

In this paper we use a gravity model of international beef trade, for 195 countries from 1996 to 2013, to study the trade impacts of FMD and BSE. Our approach is novel in taking into account both a country's official disease status and the impact of recent disease outbreaks. The distinction between disease outbreaks and being officially recognized as disease-free also matters for policy makers; there are often costly compliance activities required in order to gain disease-free recognition and some exporters may question the value of gaining this status. By accounting for these factors separately we can address important food policy issues such as whether a disease outbreak has persistent trade effects even after it is eradicated and whether official recognition of disease-free status can facilitate trade after disease eradication. The value of distinguishing between recent disease outbreaks and official disease status is shown by our finding that, in the case of FMD, the substitution by exporters away from markets that are recognized as FMD-free towards lower value markets that are not recognized as FMD-free occurs both during *and* after a disease outbreak. Similarly, a country that has experienced BSE tends to subsequently export less to markets that have not experienced BSE and more to markets that have. While exporting to a lower value market may be a better alternative than not exporting, it is still a negative shock from the exporter point of view. This substitution to lower value markets can create persistent impacts, so that the costs of a disease outbreak may be rather higher than what is shown by models that just consider the immediate impacts on trade. On the other hand, a narrative about the effect of disease outbreaks should not focus solely on markets that become closed, since these loses are somewhat mitigated by market substitution.

Our approach can be applied to any commodity affected by pests or diseases, although meaningful results are more likely for commodities with a small number of significant diseases subject to periodic outbreaks, such as FMD and BSE. It is also worth noting that FMD and BSE themselves have different characteristics: while FMD is highly contagious among animals it is not typically classified as a zoonotic disease since it rarely crosses the species barrier to affect humans; in contrast BSE is not highly contagious but is of concern as it is zoonotic so can affect humans. The growing literature using the gravity model to estimate the impact of food safety standards on trade flows, which we review in Section 2, might be informed by our approach. A disease outbreak typically means that a country no longer meets the requirements of importing markets, so exporters switch to markets that impose less stringent standards – this is analogous to the case of the food standards literature; however, we explicitly consider conditions in the exporting country in a way that the food standards literature does not.

The rest of the paper is structured as follows: Section 2 summarizes prior studies; Section 3 describes our data and the gravity model methodology; Section 4 covers the empirical results; and, Section 5 discusses the implications and concludes the paper.

2. Previous literature

Simulated impacts of animal disease outbreaks in several countries are reported in recently commissioned studies. For example, the Australian Bureau of Agricultural and Resource Economics and Sciences and the New Zealand Ministry of Primary Industries have combined Computable General Equilibrium (CGE) and epidemiology models to assess the economic impact of a foot and mouth disease outbreak (Buetre et al., 2013; Forbes and van Halderen, 2014). Similarly, in the United States, the Department of Homeland Security has modelled the costs of a FMD outbreak originating from a National Bio and Agro-Defense Facility (Pendell et al., 2015). Recent modelling studies focused on the United States are surveyed by Schroeder et al. (2015). These papers generally rely on assumptions about the likely time taken for market access to be restored after an outbreak.

While simulations inform studies of animal diseases, econometric work using cross country data to assess impacts on trade is less common. Important issues for modelling that may not have been thoroughly considered include: whether a disease outbreak has persistent effects even after it is eradicated; and, whether official recognition of disease-free status can facilitate trade after disease eradication. In the broader literature on the impact of product standards and food safety standards on trade flows, the gravity model is the most common approach (Ferro et al., 2015; Wilson et al., 2003). Drawing upon this approach, our modelling is further informed by the body of work applying gravity models to the impact of Sanitary and Phytosanitary (SPS) measures; many of which are aimed at preventing the introduction of diseases. Perhaps the most comprehensive research into SPS measures is Crivelli and Gröschl (2016), who estimate a gravity model examining different effects of SPS measures in the WTO database of specific trade concerns, considering trade at the relatively disaggregated (HS4) level.[2] The SPS measures include: conformity assessments and certification requirements; testing, inspection and approval procedures; and product characteristics, including requirements for quarantine treatment, pesticide residue levels, labeling or geographic application of measures.

Some studies focus more narrowly on meat. Yang et al. (2013) apply a gravity model to international pork trade, finding that a FMD outbreak does reduce exports during the period of the outbreak, with impacts that may depend on whether a vaccination or slaughter policy is in place. Schlueter et al. (2009) utilize a gravity model to assess the effect of six classes of SPS regulatory measures on meat trade between the world's ten largest exporters and ten largest importers. More detailed analysis is available in Schlueter (2009). A more limited analysis by Tapia et al. (2011) considers Germany and Argentina and the sanitary measures affecting their beef trade.

Other than Yang et al. (2013) none of these papers take into account the disease circumstances of an exporting country. This can matter because effects of an importing country's measures may depend on the exporting country's actual or perceived SPS status. Thus, an exporter may find a particular measure more or less stringent due to its disease status.

3. Data and methods

To analyze impacts of FMD outbreaks and of official international recognition of disease-free status we use International Animal Health Organization [OIE] data (http://www.oie.int). The changes in the incidence of FMD and BSE, according to the OIE data for the countries included in our panel, are shown in Fig. 1. On average, between 50 and 70 countries in our panel are recorded as having an FMD outbreak while the number of countries not recognized as FMD-free is about twice as high; although the latter has declined over time as more countries have become officially recognized as FMD free (without vaccination). The number of countries who have reported a BSE outbreak is much lower, but increased with the spate of outbreaks in Japan and various European countries in 2000 and 2001.

We derive two FMD outbreak variables (*FMD outbreak exporter* and *FMD outbreak both*) from OIE databases. Between 1996 and 2004, the OIE data contains the number of reported cases of FMD and the year in which an outbreak was last recorded. From 2005, the OIE uses categories for disease presence or absence; we consider there to be no outbreak if the country was classified as "Never reported" or "Disease not reported during this period".

The duration of trade impacts after an outbreak is of key interest for policy makers and modellers. The conditions and timing for regaining market access are generally not specified *ex ante* by importing countries, and in practice can depend on various features of the exporting and importing countries, including the risk tolerance of the importing

[2] This is more detailed than similar earlier work by Disdier et al. (2008).