

A new method for assessing the impact of emerging infections on global trade

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Summary

In this paper, the authors describe a new method for assessing the impact of emerging infections on global trade flows.

When one compares notifications to the World Trade Organization (WTO) of the emergency measures taken to control certain animal and plant diseases with the trade values of certain products from the United Nation's Commodity Trade Statistics Database (Comtrade) (identified through the World Customs Organization's harmonised system of tariff product codes [HS]), it is possible to estimate the extent to which trade has been diverted from the affected economies.

The authors study in detail the example of bovine spongiform encephalopathy (BSE). When member countries of the WTO change their import policies towards the goods of a trading partner, as the result of an emerging disease such as BSE, they must file notifications of such changes through the Sanitary and Phytosanitary Committee of the WTO.

To quantify the impact of BSE on trade, the authors compared these notifications against Comtrade statistics, using the HS 1996 tariff code variable. (The HS 1996 tariff codes allow the tracking and recording of the volumes of exports and imports, in quantity and value, between any two member countries between 1998 and 2000 in the database.) The authors then used this linked dataset to describe the dollar impact of the BSE-related notifications filed in 2000 on the trade flow of imports.

The results of this study suggest that economies affected by BSE notifications saw a decline of US\$5.6 billion from hypothetical projections in designated products. At the same time, unaffected economies saw an increase of US\$1.5 billion from hypothetical projections in the same products.

Thus, it may be concluded that import restrictions to control the spread of emergent spongiform encephalopathy infection had a significant effect on trade flows. These results also emphasise the interconnectedness of global trade: trade restrictions for some economies may enhance trade opportunities for others. Further studies using these methods are warranted.

Keywords

Bovine spongiform encephalopathy – Commodity trade database – Comtrade – Emerging infections – Epidemic – Global trade – Import restrictions – New variant Creutzfeldt-Jakob disease – Spongiform encephalopathy – Trade.

Introduction

Researchers are actively investigating ways of using diverse information sources to describe epidemics (10). Until now, 'non-health' data have principally been used as a tool to enhance a disease 'alert', i.e. the notification of a disease

event. However, non-health data can enhance scientific understanding of epidemics in other ways, as this report demonstrates. The authors present an analysis of an emergent epidemic event, bovine spongiform

encephalopathy (BSE) and its link to new variant Creutzfeldt-Jakob disease (nvCJD), using data from the commodities trade (Comtrade) dataset of the United Nations, to assess the impact of import restrictions on the trade in bovine products. The authors have developed and tested methods for exploiting the Comtrade dataset to more accurately characterise the emergence of new infections through their impact on global trade. Those methods are presented in this paper.

The emergence of BSE in cattle in Britain in 1986 was followed by the emergence of a human transmissible spongiform encephalopathy, nvCJD, in 1996. The emergence of the human disease is thought to be a consequence of exposure to the same prion agent that causes BSE in cattle. This exposure occurs through human consumption of contaminated bovine material (2, 3, 4). As public health and veterinary authorities came to accept this epidemiological linkage, strategies were implemented to limit human exposure to the prion through the following measures:

- a) extensive culling of affected herds
- b) new regulations governing meat harvesting practices
- c) a ban on recycling animal parts into animal feed
- d) restrictions placed on imported beef products from the United Kingdom (UK) and other infected economies, by their global trading partners
- e) the careful review of trade in potentially affected products, and the resultant assigning of BSE risk to these products by the World Organisation for Animal Health (OIE).

This last measure by the OIE was, in part, designed to increase surveillance for BSE within countries that had imported potentially infected animal feed.

History is full of examples of epidemics which have travelled the trade routes. The link between trade and infection is even more relevant in this modern era of rapid global trade. As new technologies are developed for creating food and biological derivatives, as well as preparing, conserving and shipping food and biological products, they bring with them new risks of contagion to the populations of the world (5). In this study, the authors have defined 'trade-related infections' (TRI) as infections which have the following characteristics:

- a) their emergence is associated with the rapid increase in or consolidation of production to meet global market demand
- b) their transmission and amplification occur through the trading of products across borders

c) their impact is large in terms of trade diversion or disruption through embargo or trade curtailment.

Thus, the authors consider BSE to be a TRI in that it fulfils the last two requirements of this definition. Some would argue that its origin, which was related to changes in feed production for British bovines at a particular point in time, would also qualify under the first provision. However, this link between the emergence of BSE and a change in the rendering processes for bovine foodstuffs has yet to be scientifically proven. Although the vast majority of BSE cases have occurred in the UK, the infection has also been found in countries in Asia and North America, presumably transmitted through animal feed products.

The connection between trade and health issues is not confined to concern about infectious diseases (1). However, the description and continuing surveillance of TRI presents a specific area of concern. For this reason, the design of information systems and datasets that can improve understanding of the emergence and transmission of TRI is a timely effort.

Materials and methods

Notifications through the Sanitary and Phytosanitary (SPS) Committee of the World Trade Organization (WTO) were compiled for the years from 1998 to 2000. These SPS notifications are filed by Member Economies when they change their import policy towards the goods of a trading partner. For a newly emergent disease, such as BSE, all Member Economies are required to report changes in trade policy since, by definition, no current trade regulations exist for this new infection.

While BSE-related notifications had been filed for a limited number of products since 1996, the number of notifications increased in 2000. These notifications included a variety of products and affected a larger number of economies. To quantify their impact, the following tasks were conducted:

- a) The authors linked the notification events with the Comtrade dataset, using the Harmonised System (HS) 1996 tariff code variable. The Comtrade dataset lists the volume of trade in exports and imports (in quantity and value) between any two Member Countries from 1998 to 2000 using HS 1996 tariff codes to designate specific products
- b) The authors then used the linked dataset to describe the dollar impact of BSE-related notifications filed in 2000 on import trade flow.

These steps are described in detail below.

Creation of the notifications dataset and linkage of tariff codes

The SPS Agreement requires WTO Member Economies to file 'urgent measure notifications' whenever they change their import policies in response to national or international emergencies (7). These urgent trade restrictions can be filed before a formal scientific risk assessment has been conducted and will remain in place indefinitely while scientific documentation is assembled. Notification documents include the following information:

- the country filing the notification
- the start date and duration of the trade restriction
- the trading partners which are potentially affected
- the products being restricted
- the reasons for the restriction.

The authors created a dataset of variables for each of these items and entered the information from each notification received by the WTO Secretariat between 1998 and 2000. The data from all forms were coded to include the variables for products (i.e. tariff codes) and any economies potentially affected by the trade measure, so that it was possible to link this notification information to the Comtrade dataset and then to compute the trade volumes on BSE-related products for countries of interest.

Member Economies began notifying the WTO of restrictions related to BSE in 1996, which limited the trade in bovine semen from affected countries. However, in 2000, seven economies filed nine notifications restricting trade to prevent the introduction of prions through a variety of bovine-derived materials. For example, India filed a notification (G/SPS/N/IND/7) in 2000, to 'prohibit the import into India of live cattle, buffalo; sheep and goat; bovine, ovine and caprine; embryo/ova/semen; fresh meat, meat products/tissue/organs, meat and bone meal of ruminant origin from countries where the TSE group of diseases have been reported' (8). Those products were coded into HS 1996 tariff codes. A total of 96 distinct HS tariff codes were identified from these notifications. Designations by tariff code were complete on the submitted forms for only 13% of the notifications. In other cases, where products were only named in the text (87% of notifications), the authors assigned codes based on the descriptions of commodities provided by the notifying country. Using the SPS Secretariat list of enquiry points (G/SPS/ENQ/13, June 21 2002), representatives of each reporting economy were contacted to confirm the codes attributed to their notification. (One of the seven reporting economies could not be reached by any means.)

These codes were then used to link the notification data to the Comtrade dataset for the years 1998, 1999 and 2000. Thus, for these years, the authors were able to work with the actual data on trade volumes and dollar value for the

notified products between trading partners, based on the information reported by the country to Comtrade.

Classification of economies

The authors confined their analysis to WTO Member Economies for which an SPS enquiry point had been identified (n = 127), due to the need for tariff code confirmation as described above. Analysis was then further restricted to those economies which had provided the complete relevant HS code data for each of the three years included in the study. As a result, a total of 70 economies were included as reporting economies (i.e. importers) in this analysis, including four of the seven economies which filed notifications in 2000.

These 127 Member Economies were classified according to the following two criteria:

a) they were either identified as potentially affected (n = 17), or not identified as potentially affected (n = 110) by the SPS notifications for 2000

b) the 70 Member Economies that had provided complete HS code data for all three years of the study were divided into those filing urgent measure notifications with the Secretariat in 2000 (n = 4), and those not filing notifications in 2000 (n = 66).

Using this classification scheme, the authors compiled the total trade value for the relevant HS tariff codes for the reported data in 1998, 1999 and 2000, in the four categories shown above. The temporal trend for trade volume in the relevant tariff code products was then plotted for the three-year period by year.

Results

Note: all values are given in thousands of United States (US) dollars.

In 1998, import trade for the four economies that later filed notifications to restrict trade because of BSE in 2000 totalled US\$1,530,942,380 in the notified product codes. A total of 67.4% of imports into these economies came from the trading partners they named in their 2000 notifications. The total import value of these commodities into these four economies fell to US\$1,420,484,213 in 1999 and then rose slightly to US\$1,449,722,230 in 2000.

In economies which did not notify BSE trade restrictions on these products from potentially affected economies, the value of their imports increased from US\$34,068,136 in 1998 to US\$38,455,025 in 1999, then fell to US\$37,126,436 in 2000. In other words, the year 2000

saw a decline in trade of these products of about US\$1.3 billion. On the other hand, economies which did not notify import restrictions on these products from economies which were not affected by notifications saw a rise in trade of these products in 1999 and again in 2000. Trade in designated products rose to a total of US\$32,060,288 in 1998 to US\$33,647,814 in 1999 and then to US\$36,739,567 in 2000.

After examining these trends, the authors added together the data from the 'affected' economies to create a single temporal trend graphic and did the same for all of the 'unaffected' economies.

As shown above, in 2000, there was a decline in the importation of products covered by BSE restrictions from the economies named in the notifications (i.e. the 'affected economies'). The total value of imports fell from US\$39,402,221 in 1999 to US\$38,089,515 in 2000. This decline of US\$1,312,706 was approximately 3% of the total volume in each of these years. At the same time, imports of the relevant tariff code products from Member Economies that were not named in the notifications filed for 2000 rose from US\$34,121,103 in 1999 to US\$37,226,212 in 2000. This increase of US\$3,105,109 was close to 9% of the total volume in each of these years.

Calculating the slope of the line describing the temporal trend between 1998 and 1999, the authors then projected what the values would have been if the trend for these years had continued in a simple linear fashion through 2000. These trends are shown by the broken lines in Figure 1. According to this linear projection, in the year 2000, trade from the economies named in the notifications (i.e. the 'affected economies') would have reached US\$43,704,439 in 2000. Figure 1 and Table I illustrate these trends.

Trade from economies not named in the notifications (i.e. the 'unaffected economies') would have increased to US\$35,682,842 for 2000. However, the imports from the

unaffected economies actually rose to US\$37,226,212, an increase of US\$1,543,371 from the hypothetical trade value.

It is interesting that the decline from the hypothetical trend in the value of imports of these specific products from affected Member Economies (US\$5,614,923) is so much larger than the increase from the hypothetical trend in the value of imports from unaffected economies (US\$1,543,369). The affected economies clearly experienced a decline in their ability to export the named products to the importing economies who had notified the SPS Secretariat. However, this study also indicates that the unaffected economies may have benefited from an increase in trade. Thus the 'loss' of value in trade by the affected economies may not represent an actual net loss to the global economy, but rather a shift in the traffic pattern of goods. In other words, the emergence of BSE resulted in a loss to some economies, but a gain to others.

The potential total decline in world trade extrapolated from the hypothetical trend for all economies would be somewhat smaller than the decline experienced only by the affected economies, i.e. from US\$5,614,923 to US\$1,543,369 or (US\$4,071,554) for 2000.

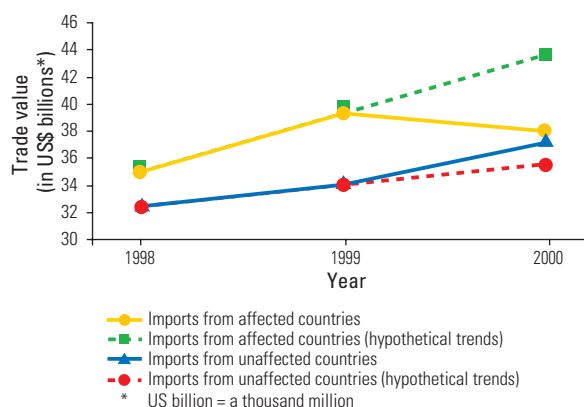


Fig. 1
A linear projection of trends in imports of products affected by bovine spongiform encephalopathy notifications between 1998 and 2000

Table I

The value of imports of products affected by bovine spongiform encephalopathy notifications between 1998 and 2000

All values are given in thousands of United States dollars

Year	Imports from affected economies	Hypothetical trend in imports from affected economies	Imports from unaffected economies	Hypothetical trend in imports from unaffected economies
1998	35,100,003	35,100,003	32,559,364	32,559,364
1999	39,402,221	39,402,221	34,121,103	34,121,103
2000	38,089,515	43,704,439	37,226,212	35,682,842

The role of the markets is not described in this method. Thus, whether this US\$4 billion is an actual loss or an apparent loss which is mitigated by domestic sales is not clear.

Discussion

Gathering the evidence to describe the economic impact of TRI is a priority for global and national policy-makers. This is particularly true, considering that international health regulations are under review, and so it is crucial that researchers enhance their knowledge of the interplay between the emergence of new infections and the flow of trade. Eventually quantifying the impact of emerging diseases in this way can only improve the risk-benefit analyses that will be required for future decisions on whether or not trade restrictions should be imposed.

However, the authors are at an early stage in the development of their methodology to acquire this much-needed evidential base. The primary advantage of this 'macro'-level assessment tool is that it moves beyond the anecdotal nature of case studies of individual economies, allowing consideration of the global trading system. In that sense, it provides information about economies which are affected by restrictions as well as about those which are not.

Temporal correlation is not sufficient to demonstrate a causal relationship. There are numerous factors that significantly affect the flow of international trade, including, but not limited to, the following:

- the pricing of goods and transportation
- consumer demand
- supply
- currency fluctuations
- national business cycles.

Nonetheless, temporal correlation is routinely used in both the professional public health and lay (non-peer reviewed) literature to ascribe economic changes to epidemic events. More formal economic methods have rarely been applied. The broad array of economic models used for forecasting economic change and describing market liberalisation between economies or for certain goods have not been tested for quantifying the economic effects of epidemic disease.

Commodity trade data suffer from a variety of limitations as a tool for analysis. These data are not complete for all economies, for all years or for all products. They are rarely independently verified, and may be subject to a variety of errors, such as misclassification of product, inconsistent reporting within and between economies, and errors in

calculating value. In this initial report, the authors have not attempted to apply methods to correct these limitations.

Simple linear projections are clearly inadequate to estimate the import trade that 'might have been' in 2000 in both the 'affected' and 'unaffected' group of economies studied by the authors. In addition, although classifying these economies into four categories seems to be a major determinant of import trade in this particular study, the authors are aware that import demand for the products of other countries is a function of various factors, such as:

- national income
- the price of the imported product
- technologies
- costs of factors
- the prices of related commodities.

Therefore, the authors are applying formal econometric modelling techniques on their linked dataset to confirm these findings. The extended time-series dataset available through Comtrade facilitates this work, in that all data before the first notifications can be used to model trends between trading partners and projections for those years potentially affected by notifications.

The initial results of this study suggest that a simple linear treatment underestimates the potential value of diverted trade. The robustness of this approach will be determined in part by the time period for which comparable data are available. As seen in this study, complete data for stipulated codes from the urgent measure notifications in 2000 were available for just over half the WTO Member Economies reporting through Comtrade during this three-year period. The completeness of such data will clearly be an issue in the application of econometric techniques.

The OIE has a central role in creating international standards to ensure the safety of foods of animal origin. The tariff code linkage reported by the authors could provide a rich information resource to evaluate the impact of implementing these standards. However, the Comtrade dataset would be a far greater asset if it were complete and the quality of its data was confirmed.

Conclusion

In summary, this research provides a new method for creating a rich data resource for examining the disruption caused to trade when a new human pathogen emerges. The authors use this data resource to create a simple linear projection which describes the decline in the value of imported goods over a three-year period. This decline was temporally correlated with the filing of urgent measure notifications by importing Member Economies. These

urgent measures were the result of the desire of importing countries to prevent the importation of prion disease into their animal and human populations. The exact dollar value of the decline cannot be determined by these methods. However, additional research to refine and confirm these methods, using more traditional equilibrium trade flow models, is strongly recommended.

Thus, the authors urge further investigation of the usefulness of this dataset when attempting to describe the impact of a newly emergent epidemic disease on global trade. Clearly, TRI will continue to occur. New human infectious agents, such as the coronavirus causing severe acute respiratory syndrome (SARS), are believed to have reservoirs in other vertebrates, raising fears of accidental introduction through the importation of animal-derived foodstuffs. The SPS Secretariat received an urgent measure notification related to SARS in 2003 (9). Considering the

international scope of modern epidemics, and the increasing importance of trade in livestock and livestock products (6), the challenge of accurate description requires new methods and new information sets. This study suggests that linking routinely collected trade data and epidemic reporting may contribute to the evidence needed for responsible decision-making in this area.

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Nouvelle méthode d'évaluation de l'impact des infections émergentes sur le commerce mondial

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Résumé

Les auteurs décrivent une nouvelle méthode destinée à évaluer l'impact des infections émergentes sur les échanges commerciaux à l'échelle mondiale.

Il est possible, en comparant les notifications à l'Organisation mondiale du commerce (OMC) des mesures d'urgence introduites contre les maladies des animaux ou des végétaux à la valeur commerciale de divers produits repris dans la base de données sur le commerce des produits de base des Nations Unies (*Comtrade*) (identifiés par le Système harmonisé des codes produit tarifaires de l'Organisation mondiale des douanes), d'estimer l'ampleur des échanges commerciaux soustraits aux économies des pays concernés.

En guise d'exemple, les auteurs analysent en détail le cas de l'encéphalopathie spongiforme bovine (ESB). Face à une maladie émergente comme l'ESB, les pays membres de l'OMC qui modifient leur politique d'importation à l'égard des produits d'un partenaire commercial doivent en informer l'OMC en notifiant son Comité sanitaire et phytosanitaire.

Afin de quantifier l'impact de l'ESB sur les échanges commerciaux, les auteurs ont comparé ces notifications aux informations extraites de *Comtrade* en utilisant la variable « code tarifaire » 1996 du Système harmonisé (les codes tarifaires 1996 du Système harmonisé permettent d'évaluer et d'enregistrer le volume et la valeur des exportations et des importations entre tous les pays membres pris deux à deux entre 1998 et 2000 dans la base de données). Grâce à cet ensemble de données liées, les auteurs ont estimé l'impact financier (en dollars américains) sur le flux commercial des importations des notifications relatives à l'ESB envoyées en 2000.

Según los resultados de esta estudio, las economías concernidas por las notificaciones de l'ESB ont acusado una pérdida de 5,6 mil millones de dólares estadounidenses sobre los productos especificados, por comparación a las previsiones hipotéticas. En el mismo tiempo, las economías no concernidas habían registrado un aumento de 1,5 mil millones de dólares estadounidenses para los mismos productos y previsiones.

Es así que se permite concluir que las restricciones a la importación puestas en marcha para controlar la propagación de l'ESB ont profundamente marcado los flujos comerciales. Los resultados de l'estudio ponen también en luz la interconexión de los intercambios internacionales: la puesta en marcha de restricciones comerciales en ciertas economías puede estimular los intercambios con otros países. Estudios complementarios basados en la misma metodología son necesarios.

Mots-clés

Base de datos sobre el comercio de productos básicos – Comercio – Comercio mundial – Comtrade – Intercambios comerciales mundiales – Encefalopatía esponjosa – Encefalopatía esponjosa bovina – Epidemia – Infección emergente – Nueva variante de la enfermedad de Creutzfeldt-Jakob – Restricción a la importación.



Nuevo método para evaluar la influencia de las infecciones emergentes en el comercio mundial

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Resumen

Los autores describen un nuevo método para evaluar la influencia de las infecciones emergentes sobre los intercambios comerciales que tienen lugar en el mundo.

Comparando las notificaciones enviadas a la Organización Mundial del Comercio (OMC) sobre las medidas de emergencia adoptadas para combatir ciertas enfermedades animales y vegetales con el valor del comercio de determinadas mercancías, según figura en la Base de datos sobre estadísticas del comercio de productos de las Naciones Unidas (*Comtrade*) (con un código del sistema armonizado de tarifas para cada producto de la Organización Mundial de Aduanas), es posible estimar la medida en que el comercio ha rehusado las economías afectadas.

Los autores estudian detenidamente el ejemplo de la encefalopatía esponjosa bovina (EEB). Cuando los países miembros de la OMC modifican su política de importación respecto a las mercancías de un socio comercial a causa de una enfermedad emergente como la EEB, deben presentar una notificación en la que den cuenta de esos cambios por conducto del Comité de Medidas Sanitarias y Fitosanitarias de la OMC.

Para cuantificar la incidencia de la EEB en el comercio, los autores compararon esas notificaciones con las estadísticas de la *Comtrade*, utilizando como variable los códigos del sistema armonizado (SA) de 1996. (Los códigos de tarifas del SA 1996 permiten el seguimiento y listado de los volúmenes y el importe de las exportaciones e importaciones entre dos países miembros entre 1998 y 2000 en la base de datos.) A continuación, los autores utilizaron esta serie de datos conectados para cifrar (en dólares) los efectos sobre las importaciones que tuvieron las notificaciones relativas a la EEB presentadas en 2000.

Los resultados del estudio parecen indicar que las economías afectadas por notificaciones de EEB experimentaron un retroceso cifrado en 5.600 millones de dólares con respecto a las proyecciones referentes a los productos en cuestión. Paralelamente, las economías indemnes ganaban 1.500 millones de dólares con respecto a las proyecciones para los mismos productos.

Cabe deducir, por consiguiente, que las restricciones a la importación para atajar la propagación de la encefalopatía espongiforme emergente influyeron sustancialmente en los intercambios comerciales. Estos resultados ponen también de relieve las interconexiones que atraviesan el comercio mundial: las restricciones comerciales aplicadas a ciertas economías pueden suponer mejores oportunidades para otras. Será necesario llevar a cabo otros estudios con esta metodología.

Palabras clave

Base de datos sobre estadísticas del comercio de productos – Comercio – Comercio mundial – Comtrade – Encefalopatía espongiforme – Encefalopatía espongiforme bovina – Epidemia – Infección emergente – Nueva variante de la enfermedad de Creutzfeldt-Jakob – Restricciones a la importación.



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