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Avian Influenza, Nontariff Measures, and the Poultry Exports in the Global Value Chain*[1]

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Abstract

This paper focuses on the direct impact of avian influenza outbreaks and the impact of the consequent nontariff measures on the international poultry trade in the Global Value Chain Context. Using monthly export data regarding China and its 122 poultry importing countries, a random-effect gravity model is adopted. The research analysis distinguishes between "agri-food goods" (mostly uncooked poultry products) and "processed goods" (mostly cooked poultry products) to understand the trade in global value chain. The results show that domestic avian influenza outbreaks have a large and significant negative impact on a country's poultry imports compared with such outbreaks in exporting countries. Moreover, nontariff measures induced by avian influenza reduce the uncooked poultry trade but increase the cooked poultry trade temporarily. The results also imply that developing countries that attempt to participate in the global agri-food value chain to access developed countries' markets should increase and enhance processed food production for more-value adding and competiveness.

Keywords: poultry trade, non-tariff measures, processing trade

JEL classification: F14, O24, Q17

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Introduction

Avian influenza (AI) outbreaks have frequently occurred with significant impacts not only on food safety and health concerns, but also on economic activities such as the international poultry trade. AI, commonly known as bird flu, is a highly contagious viral disease that affects several species of birds, including food-producing birds such as chicken. Sometimes, human infections caused by the AI virus may also occur (CDC 2016; OIE 2016). From January 2014 to December 2016, 783 cases of highly pathogenic avian influenza (HPAI) outbreaks occurred in 54 countries (OIE 2016). The impact of AI outbreaks on the poultry trade is obvious. Global AI outbreaks during the last quarter of 2003 led to a 23% drop of global poultry meat exports by the end of March 2004, which represents an immediate fall in exports within two quarters. For example, in 2004, Thailand, one of the world's top poultry exporters, experienced an outbreak of H5N1, an influenza A virus subtype. Subsequently, the country's frozen chicken products were banned by its top three importers: Japan, Germany, and Korea. The ban resulted in a 93% fall in exports compared with 2003 (Puthavathana 2006).

In addition to the impact on direct trade demand, AI outbreaks also influence trading countries' policymaking for related products. Because of public health concern, many governments impose nontariff measures (NTMs) such as sanitary and phytosanitary (SPS) measures and technical barriers (TB) on poultry imports from AI-infected countries when the outbreaks occur. According to SPS notification information from the World Trade Organization (WTO), approximately 40% of NTMs for the world poultry trade have been raised directly because of AI outbreaks from January 2005 to December 2013. A further example is the suspension by the United States of the importation of Chinese cooked poultry meat for five years (from 2006 to 2010) because of the presence of HPAI in China (WTO 2011)

By analyzing the indirect impact of AI on the poultry trade through NTMs, trade flow changes can be captured as a foundation for NTM analysis.

The literature studying the impact of AI and related NTMs on the poultry trade can be grouped into two types: 1) simulations of the effects of AI outbreaks on trade and welfare in major countries and regions (Peterson and Orden 2005; Djunaidi and Djunaidi 2007; Wieck et al. 2012) and 2) empirical trade flow analysis on the impacts of AI outbreaks on NTMs, focused mainly on developed countries because of data availability (Paarlberg et al. 2007; Taha 2007; Disdier et al. 2008). Such research has shown the importance of AI outbreaks on the poultry trade from different perspectives such as rising global export prices (Djunaidi and Djunaidi 2007), the confirmation of large country effects (Djunaidi and Djunaidi 2007), and regionalization and producer welfare (Paarlberg et al. 2007). The impact of AI-related NTMs on the poultry trade has also been captured from perspectives such as the trade diversion effects from NTMs (Wieck et al. 2012) and developing countries facing NTMs imposed by developed countries (Disdier et al. 2008; Jongwanich, 2009).

However, with recent globalization and tariff reduction trends, will prior results still hold? In our research, we consider two points in order to fill a gap in the literature. 1) We use monthly trade data, specifically data differentiating uncooked and cooked poultry products, in order to analyze exports from a developing country, China. 2) We differentiate between importing trade partners by size and focus on importers from developed countries in order to study NTM effects further. Moreover, our research aims to use a detailed case study to highlight the impact of NTMs imposed by developed countries' importers on developing countries' exporters and to analyze the different responses between the processing (cooked products) trade and the regular agricultural food trade to AI outbreaks and related NTMs.

In order to study the impact of an AI outbreak on the poultry trade and the indirect impact of related NTMs, we have chosen the Chinese case for the following five reasons. 1) China has been the second largest poultry producer in the world over the past two decades. It accounted for approximately 15% of global poultry production from 2005 to 2013, second only to the United States at 25%. 2) China has been a major exporter of poultry products. From 2005 to 2013, China has been the seventh largest poultry product exporter in the world. Moreover, China is the third largest exporter of cooked poultry products, accounting for approximately 13.8% of global cooked poultry exports. 3) China exports both uncooked and cooked poultry products. AI outbreaks may affect both types of product in different ways. 4) A large number of countries import poultry products from China. Among the 122 importing countries, there are countries with high incidences of AI outbreaks (e.g., Bangladesh, Cambodia, India, Indonesia, Laos, and Vietnam), and also countries free from AI (e.g., Bahrain, Singapore, Armenia, the United Arab Emirates, and the Philippines). In addition, China itself has also suffered from occasional AI outbreaks. During 2005–2013, 34 cases of

HPAI) and 23 of low pathogenic avian influenza (LPAI)[1] were reported by China to the World Organisation for Animal Health (OIE). In addition, among the 122 importing countries, the developed countries tend to import cooked poultry products while the less-developed countries tend to import uncooked poultry products. This heterogeneity among the importing country sample can lead to an interesting analysis. 5) As one of the largest and most active economic bodies, China has been participating in a number of free trade agreements and economic zones, and has been facing and has raised various trade frictions (WTO 2011). Based on the foregoing reasons, it is worth investigating China's poultry trade as a case study in order to discuss the direct impact of AI outbreaks on the poultry trade and the indirect impact through NTMs.

Background

In order to study the influence of AI outbreaks on the poultry trade more effectively, we distinguish between the uncooked poultry trade and the cooked poultry trade. This differentiation enables us to conduct an analysis from the global value chain prospective of the poultry trade in the following sections. Uncooked poultry products are known as agricultural raw ingredient intermediate goods and cooked poultry products are known as processed final goods. The two poultry trade flows have demonstrated different trends (see

[1] Avian influenza is defined by the OIE as an infection of poultry and other birds that is caused by any influenza, a virus with high pathogenicity (HPAI), and by H5 and H7 subtypes with low pathogenicity. In accordance with the severity of the disease in poultry, AI virus strains are usually classified into two categories: HPAI and LPAI. HPAI can cause severe clinical signs and potentially high mortality rates among poultry. LPAI strains cause few or no clinical signs in poultry; however, they are likely to become highly pathogenic through mutation.

appendix, Table 3). In the past decade, global exports of cooked poultry products have increased from approximately 2.61 million tons in 2005 to more than 4 million tons in 2015. Global exports of uncooked poultry products have also increased from nearly 19 million tons to approximately 30 million tons in the same period. Asia is the leading regional exporter of prepared poultry products. From 2005 to 2015, Thailand and China shipped more than 35% of global cooked poultry exports (approximately 14 million tons). Japan was the largest buyer, followed by the UK and Germany. Together, the three countries purchased more than 8 million tons during this period. Uncooked poultry exports account for approximately 87.83% of global poultry exports. Cooked poultry exports account for approximately 12.17% of global poultry exports. These percentages have been stable throughout the 10-year period. From 2009 to 2010, the percentage of cooked poultry exports was relatively low, at approximately 11.82% on average. With regard to the other years in the 10-year period, the percentage was a little higher at 12.25%. The fall in cooked poultry exports may have been due to less frequent AI outbreaks from 2009 to 2010 (new outbreaks were few, with only 18 HPAI outbreaks in small poultry markets). When HPAI outbreaks were fewer, the uncooked poultry trade was more active than the cooked poultry trade. Further, the global trade in processed poultry products has increased as a result of some importing countries imposing bans on shipments of fresh/frozen products from countries affected by AI. However, the difference in the market share of cooked poultry exports is not very significant. The reason could be that although policies (NTMs such as import bans) differ for cooked and uncooked products when AI occurs, consumers remain the same.

In addition, uncooked and cooked poultry trade flows are affected by AI outbreaks in different ways through NTMs. The World Trade Organization's (WTO's) Integrated Trade Intelligence Portal (I-TIP) Goods service provides comprehensive information on NTMs applied by WTO members in the merchandise trade. From 1995 to 2015, all 514 records of NTMs induced by AI are SPS measures. Among the 514 SPS records, there are 14 relating to uncooked and cooked poultry products simultaneously, 415 relating to uncooked poultry products only, and 99 relating to live poultry and poultry eggs (see Figure 1). No records relate to cooked poultry products only. In addition, 382 records apply to all WTO members and only three are directed against China (two issued by the Philippines in 2013 and 2014 and one issued by Ukraine in 2012). All 514 SPS records aim to stop the import of specific poultry products from countries affected by HPAI outbreaks.

[Insert Figure 1]

In order to understand the implementation scheme of NTMs induced by AI outbreaks more effectively, we summarize our observations in the appendix, Table 3. The table is based on information from AI outbreak information of the OIE and NTM information of the WTO. We observe that when AI outbreaks occur, importing countries may impose NTMs on poultry imports. However, the imposition of NTMs does not necessarily happen every time there is an AI outbreak, given that the total number of NTMs (1472) is far less than the total number of AI outbreaks (6463). Depending on regionalization, poultry products that meet certain quality standards can be traded without the risk of spreading the AI virus through the commercial poultry trade (Beato and Capua 2011). However, domestic AI outbreaks in importing countries are more likely to affect the countries imposition of NTMs. When importing countries experience domestic AI outbreaks, the NTMs they impose on imported poultry products not only imply that they only import safe poultry products but also emphasize to domestic consumers that all current domestic poultry markets are safe and AI free.

This paper is divided into the following sections. The section entitled "Theory and Methodology" introduces the model and the data used in the paper; the section entitled "Estimation Results" discusses the regression results; and the section entitled "Conclusion" provides the conclusions.

Theory and Methodology

Data

In order to study Chinese poultry exports, we use data from several sources. Detailed information about the data is available in the appendix, Tables 4 and 5. Monthly poultry exports data are obtained from the Administration of China's Customs agency. Poultry production, from inception to slaughterhouse, takes approximately 34 days on average (González-García et al. 2014). The AI outbreak cycle depends on the detection and time control of individual cases. The cycle varies from five to ten months; for example, during the HPAI outbreaks in 2004 and 2007 (Sugiura et al. 2009). Thus, in order to capture the impact of AI outbreaks on the poultry trade promptly and accurately, we use monthly trade data in accordance with the Harmonized System of Classification (hereafter HS) eight-digits level. The data cover 2005 to 2013. During this period, 122 countries imported poultry products from China. European Union member countries are considered individually. Trade flows between China and Hong Kong and between China and Macau are excluded from our sample because of the close political ties. In terms of poultry products, we differentiate between cooked and uncooked products.[2] Uncooked products include frozen poultry cuts without bones and frozen offal. Cooked products include prepared or preserved meat, canned meat, and offal. All poultry products from chicken, ducks, and geese are included. From China, 11 uncooked poultry products and eight cooked poultry products at the HS eight-digit level were imported by 122 countries.

Information on AI outbreaks in China and the 122 trading partners were obtained from the OIE. Each country's government is obliged to report its domestic outbreaks of AI to the OIE. Such reports should distinguish HPAI and LPAI (in accordance with the relevant virus) and include the official date of outbreaks in birds, the type of avian influenza virus, cases of new outbreaks, and the numbers of total susceptible animals.[3] Based on the cases of new outbreaks, we can obtain information on whether AI outbreaks occur in China and its trading partners. From 2005 to 2014, there were 34 HPAI outbreaks and 23 LPAI outbreaks in China, and 3,399 HPAI outbreaks and 197 LPAI outbreaks in the 122 importing countries. There is a possibility that LPAI outbreaks may develop into HPAI outbreaks (OIE 2016). However, this

[2] Uncooked poultry are products with the following HS codes: 2071200, 2071411, 2071419, 2071421, 2071422, 2071429, 2072700, 2073210, 2073310, 2073320, and 2073610. Cooked poultry are products with the following HS codes: 16023100, 16023210, 16023291, 16023292, 16023299, 16023910, 16023991, and 16023999. A detailed description of poultry products is available in the appendix, Table 1.

[3] Information on AI outbreaks is collected from the World Animal Health Information Database (WAHIS Interface) developed by OIE. The monthly data covers information on new outbreaks, the total of dead animals, the total cases, the total of animals slaughtered, the total of animals destroyed, the total of susceptible animals, and the total of animals vaccinated. Considering data quality, data on new outbreaks, the total of dead animals, and the total of susceptible animals are most likely to account for the severity of AI outbreaks. However, as data on the total of dead animals only covers HPAI outbreaks because cases of animal death caused by the LPAI virus are rare, the total of susceptible animals is preferred.

possibility is negligible in our sample because the impacts of HPAI and LPAI are measured separately. Among the 122 countries that trade with China in poultry, 66 are free from AI, 38 only experienced HPAI, six only experienced LPAI, and five suffered from HPAI and LPAI.

Data on NTMs at the four-digit HS level were collected from the WTO website. The NTM information includes members' notifications of NTMs as well as information on specific trade concerns (STCs) raised by members at WTO committee meetings. WTO members must notify their nontariff measures to the WTO. Each notification covers information on the notifying country; the affected country and product; the type of barrier; and the dates[4] of initiation, implementation, and revocation of the barrier. Data on notifications are not necessarily available in terms of a bilateral dimension. With rare exceptions, measures are enforced unilaterally by importing countries and applicable to all exporting countries. Our empirical analysis focuses on measures notified under the SPS measures and technical barriers to trade (TBT) Agreements. There are 523 SPS and 547 TBT measures on poultry products initiated by China's 122 trading partner countries in the sample period (not necessarily after AI outbreaks). Using these data, we estimate econometrically the impact of AI outbreaks on SPS and TBT measures and then consider the policy effects of AI outbreaks.

There are 34,668 observations in total in our balanced panel sample. Among these, 35% apply to China's uncooked poultry exports and 65% to China's cooked poultry exports. In terms of trade volume, cooked exports are about five times the volume of uncooked exports. In terms of trade value, cooked exports are more than 10 times the value of uncooked exports. The number diverges so significantly because the price of cooked poultry products is higher.

[4] Sometimes the in-force date is missing. Alternatively, the initiation date is used to represent it.

Our sample also has the common characteristics of trade data. There are prevailing zero trade flows for approximately 29,409 observations, which represents approximately 84.83% of the total observations. Uncooked poultry products have approximately 85.79% zero trade flows and cooked poultry products have 84.33%. In addition, country-level characteristics and trade information are included in the data set. We obtained the information on the free trade area (FTA) of each trading partner country and China from the service network of China’s FTA. Annual data on GDP were from the World Bank. We also include bilateral data on geographic distances and shared borders from the Centre d’Etudes Prospectives et d’Informations Internationales. Descriptions and summary statistics of all the variables can be found in Table 1.

[Insert Table 1]

The baseline gravity model

We adopt a gravity model to study the impact of AI outbreaks on the poultry product trade between China and its trading partners. Following Peterson et al. (2013), the export quantity of commodity *k* from region *i* (i.e., China) to *j*, x_{ijk}, can be represented by a constant elasticity of substitution (CES) model as follows:

$$(1) \quad x_{ijk} = \alpha_{ijk} (T_{ijk} P_{ik})^{-\sigma_k} E_{jk} PI_{jk}^{\sigma_k - 1},$$

with α_{ijk} representing the preference parameter, σ_k representing the elasticity of substitution between all varieties of commodity *k*, and P_{ik} representing producer prices in the country of origin. E_{jk} and PI_{jk} are the expenditure and price indexes respectively of commodity *k* in region *j*. T_{ijk} represents all the trading costs associated with selling commodity *k* from region *i* to region *j*.

In order to estimate this equation, E_{jk} is given a proxy of the gross domestic products (GDPs) of region *k*. Trading costs are measured using the bilateral capital distance between both partners. In addition, because of the tariff reduction in the agricultural sector, we follow prior studies by excluding tariffs faced by country *i*'s exporters in *j* in the gravity equation (Otsuki et al. 2001). Empirical studies also show that the effects of tariffs on the poultry trade are not significant (Wieck et al. 2012). However, in order to distinguish the potential impact of tariffs on the poultry trade from the potential impact on AI outbreaks, two dummies, namely WTO_{ijt}, and FTA_{ijt} are included in our econometric model. The WTO system, by design, focuses on mutually agreed reductions of trade barriers. Members that negotiate reciprocal most favored nation (MFN) tariff cuts with other members are more likely to enjoy expanded bilateral trade than non-members that do not (Subramanian and Wei 2007). The impact of WTO membership on the poultry trade may be significantly positive. In addition, as suggested by Baier and Bergstrand (2004), FTAs enhance trade because the presence of an FTA aims to increase trade among members by removing trade barriers, such as tariff concessions.

A major concern about the gravity equation in empirical studies is selection bias. When taking a logarithm to estimate the equation, the dependent variable has to be limited to country pairs where trade is strictly positive. The bias caused by the omission of zero trade flows from the gravity model has recently been documented by Santos Silva and Tenreyro (2006) and Helpman, Melitz, and Rubinstein (2008). If there are large unobservable trade barriers that are potentially correlated with the variables in trade costs T_{ijk}, zero trade flow is observed when none of the firms in the potential exporting country is productive enough to overcome the fixed costs imposed by the destination market. As defined by Heckman (1979), the omission or mistreatment of zeros in our sample could lead to sample selection bias.

The way in which to deal with zero-valued trade flows when estimating gravity equation parameters has been discussed widely. However, no commonly accepted solution has yet been reached. In dealing with zero trade observations, the common practice is to delete the zeros completely or substitute the zeros with a small positive constant. However, these methods are considered inappropriate because they are without any strong theoretical or empirical justification and can distort the results significantly (Linders and Groot 2006; Burger et al. 2009). Heckman (1979) also posits that deleting may lead to information loss and adding an arbitrary constant can result in selection bias. Several more appropriate estimation techniques, such as the Tobit model proposed by Tobit (1958) and the sample selection model developed by Heckman (1979) and Helpman et al. (2008), have been employed to deal with zero trade flow issues. However, the Heckman sample selection model[5] and the Tobit model[6] have been criticized on the grounds that they may deliver biased estimates when trade data exhibits heteroscedasticity[7] (Santos Silva and Tenreyro 2009). The Poisson pseudo-maximum

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[5] The new trade theory, pioneered by Melitz (2003), posits that the absence of trade can be attributed to firms' self-selection behavior and suggests that zeros can be seen as generated from a selection process, which gives credence to the Heckman sample selection model (Heckman 1979) and, to a lesser degree, the Tobit model (Eaton and Tamura 1994). In a Heckman sample selection model, the selection equation fully captures zeros and explains why trade takes place, while the outcome equation characterizes the volume of trade conditional on trade occurring.

[6] The Tobit model treats zeros as censored outcomes and assumes that there is a minimal threshold to jump if trade flows are to be observed (Eaton and Tamura 1994).

[7] As Santos Silva and Tenreyro (2006) show, if the true gravity equation model is in its multiplicative form and

likelihood (PPML) estimator,[8] proposed by Santos Silva and Tenreyro, accounts for zero trade flows naturally and has been shown to be robust to a wide range of heteroscedastic patterns.

In a model with finite numbers of importers and exporters, the PPML estimators can be advanced to the multinomial pseudo-maximum likelihood (MNPML) estimators. The MNPML estimators feature a dependent variable of *market share*. In our case study, raw poultry exports flow from China to importing countries as a proportion of China's total poultry exports. With *market share* as a dependent variable, MNPML estimators are able to range from trivial to large levels of trade. Moreover, shares prevent this dependent variable from obtaining values greater than one (Head and Mayer 2014). Taking the characteristics of our sample data, 84.83% of which are zeros, we apply the MNPML estimator to the gravity equation. According to studies on international trade (Kareem et al. 2014; Head and Mayer 2014), the MNPML estimator is the preferred estimator when there is a high percentage of zero trade flows with a finite number of buyers and sellers. With regard to the MNPML estimator, the market share $\pi_{ijkt} = x_{ijkt} / x_{ikt}$ of the exporting country *i* is used as the dependent variable, instead of x_{ijkt} as with other estimators (Head and Mayer 2015). Thus, with all the proxies and dummies, a gravity equation is presented below. Hereafter, for simplicity, the exporting region *i* is denoted as *c* (China) and the importing region *j* is denoted as *p* (partner).

(2) $\pi_{cpkt} = \alpha_{cpk} + \delta_1 AI_{ct} + \delta_2 AI_{pt} + \delta_3 \ln GDP_{ct} + \delta_4 \ln GDP_{pt}$

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heteroskedasticity is present, estimates from log-linearized gravity equation models can be severely biased.

[8] The PPML estimator permits zeros by estimating trade flows in levels. Some variants of the PPML estimator are also proposed. For example, Burger et al. (2009) consider the negative binomial pseudo-maximum likelihood estimator (NBPML) and the zero-inflated Poisson pseudo-maximum likelihood estimator (ZIPPML).

$$+\delta_5 WTO_{cpt} + \delta_6 FTA_{cpt} + \delta_7 Border_{cp} + \delta_8 \ln Distance_{cp}$$

$$+\sum_{y=2006}^{2013} Year_y + \sum_{m=2}^{12} Month_m + \varepsilon_{cpk_1}$$

In equation (2) π_{cpkt} is the market share at time *t*; AI_{ct} represents the AI status of *c* at time *t*, whether there is an outbreak or not; AI_{pt} represents the AI status of *p* at time *t*, whether there is an outbreak or not; GDP_{ct} and GDP_{pt} are measured in real terms for the year 2000 in US dollars; WTO_{cpt} is a binary variable that equals one if both region *c* and *p* are members of the WTO at time *t*; FTA_{cpt} is a dummy that is one if region *c* and *p* are part of the same FTA at time *t*; $Distance_{cp}$ is the geographical distance between the capitals of countries *c* and *p* measured in kilometers; $Border_{cp}$ is a dummy that is one if region *c* and *p* share a land border; $Year_y$ and $Month_m$ are the dummies for years and months respectively; and ε_{cpk_1} is the remaining error term.

Our data sample only includes China and countries importing poultry products from China. However, information on other poultry exporters that export poultry products to the 122 importing countries in competition with China are not included in the data set. The reason is the limited availability of monthly export data from these exporting countries. Given the panel nature of our sample data, it is important to adopt an appropriate econometric method to avoid heterogeneity biases and separate time-series and cross-sectional effects. Some studies (Otsuki, Wilson, and Sewadeh 2001; Wilson and Otsuki 2004; Disdier et al. 2008) use fixed-effects models in order to control the country-specific fixed effects that may affect trade flows. These fixed effects include consumption preferences and each country’s multilateral resistance when faced with partners in the rest of the world (Anderson and van Wincoop 2003; Feenstra 2004). However, fixed-effect estimators eliminate all time-invariant variation such as the geographic distance between trading countries (Egger and Pfaffermayr 2004). Hence, following Anders and Caswell (2009), we treat corresponding country effects as random and adopt random-effect estimators, given the importance of the time-constant distance variable for trade flow analysis. However, the Hausman test results are reported with each regression model. In addition, we introduce time dummies in the gravity model to capture the time trends that could affect the poultry product trade at annual and monthly levels, besides the AI outbreaks. Because this study covers 2005 through 2013, there are nine year-dummy variables in our econometric model. Further, the dummy for 2005 is omitted. Twelve month-dummies are in the model, and the dummy for January is dropped.

Policy effects of AI

NTMs play a significant role in the agri-food trade, including the poultry trade (Rae and Josling 2003; Disdier et al. 2008; Schlueter et al. 2009; Wieck et al. 2012). In the WTO system, importing nations have the right to use NTMs to protect their own poultry populations from the introduction of diseases such as AI. NTMs include SPS measures, TBT measures, quantitative restrictions, anti-dumping measures, special safeguards, and tariff-rate quotas. In our case study, most NTMs imposed by China's trading partner countries are SPS and TBT measures. Quite a number of studies have investigated the effects of NTMs on the meat trade (Alston and Scobie 1987; Paarlberg and Lee 1998; Peterson and Orden 2005; Schlueter et al. 2009), the impact of animal diseases on the animal product trade (Djunaidi and Djunaidi 2007; Kawashima and Sari 2010; Tozer and Marsh 2012), and the impact of animal disease related regulatory policies on the poultry meat trade (Wieck et al. 2012). However, to the best of our knowledge, the issue about the way in which animal disease outbreaks would affect the presence of trade measures and then influence the animal product trade, namely the extent to which animal disease outbreaks influence trade by affecting trade policymaking, has so far received little attention in the literature. Hence, in this research we are going to estimate the indirect impact of AI on trade through policy effects.

In order to measure the indirect effects of AI outbreaks, we undertake estimations in two stages. At the first stage, we identify the effects of AI outbreaks on the importing countries that imposed NTMs. In our case study, most NTMs imposed by China's trading partner countries are SPS and TBT measures. The number of remaining NTMs is few.[9] We only focus on the effects of AI outbreaks on the presence of SPS and TBT measures. In the subsample of uncooked poultry, there are approximately 4.33% SPS measures and 1.87% TBT measures imposed as NTMs when there were AI outbreaks. In the subsample of cooked poultry, there are approximately 1.09% SPS measures and 2.58% TBT measures imposed as NTMs when there were AI outbreaks. Given the small NTM implementation rate in total, we simply add both of the foregoing figures together as NTMs. We construct a dummy variable to account for this NTM variable. The variable equals one when there are new cases notified to the WTO at the four-digit HS level[10] in a particular month. The estimation equation is as follows:

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[9] Countries importing uncooked poultry from China have implemented 396 SPS measures, 224 TBT measures, three quantitative restrictions (QRs), and 11 special agricultural safeguard (SSG) measures during 2005–13. Countries importing cooked poultry from China have implemented 127 SPS measures, 323 TBT measures, five QRs, and four SSG measures during 2005–13. It is difficult to assess empirically the impact of AI outbreaks on importers that implement QRs and SSG measures.

[10] There are also limited cases of notifications at the two-digit and eight-digit HS levels. We have matched these to the four-digit level.

(3) $$NTM_{pkt} = \varphi_{pk} + \varphi_1 AI_{ct} + \varphi_2 AI_{pt} + \varphi_3 NTM_{pkt}(\text{-}1) + \varphi_4 \ln GDP_{ct} + \varphi_5 \ln GDP_{pt}$$

$$+\varphi_6 WTO_{cpt} + \varphi_7 FTA_{cpt} + \varphi_8 Border_{cp} + \varphi_9 \ln Distance_{cp} + \varepsilon_{pk1},$$

where NTM_{pkt} is 1 when there is either an SPS or TBT measure covering commodity *k* from country *p* at time *t*; the variable $NTM_{pkt}(\text{-}1)$ equals 1 if there are NTMs applied to the same product in the last month; ε_{pk1} is a remaining error term; and φ_{pk} is the constant term. The remaining variables are defined in the same way as in equation (2). In order to estimate the first stage equation (3), we use a Probit estimation framework to manage the prevalence of zeros.

At the second stage, we distinguish between the policy effects and non-policy effects of AI outbreaks. The predicted values of NTMs from the first stage are used in the gravity model to capture the policy impact of AI outbreaks as follows:

(4) $$\pi_{cpkt} = \alpha_{pk} + \gamma_1 AI_{ct} + \gamma_2 AI_{pt} + \gamma_3 N\hat{T}M_{pkt} + \gamma_4 \ln GDP_{ct} + \gamma_5 \ln GDP_{pt}$$

$$+\gamma_6 WTO_{cpt} + \gamma_7 FTA_{cpt} + \gamma_8 Border_{cp} + \gamma_9 \ln Distance_{cp} + \varepsilon_{pk2}.$$

The structure of equation (4) follows equation (2) except that the predicted values of the policy variable *NTM* from the first stage are added. Year and month dummies are omitted in order to simplify writing. The parameters of interest are γ_1, γ_2 and γ_3. The former two measure the non-policy effects of AI outbreaks, including the impact of AI outbreaks on consumer demand and producer supply. The latter measures the policy effects on China's poultry exports during AI outbreaks in China and its importers.

Demand for poultry products is assumed to decline at least in the short run because of consumer concerns about AI outbreaks (Djunaidi and Djunaidi 2007). On the demand side, avian influenza outbreaks seem not to have significantly affected demand. Initially, import demand for both uncooked and cooked poultry declined substantially because of consumers' fear of contracting avian influenza by eating poultry meat. However, these reductions proved to be short-lived because prices, consumption, production, and exports returned to pre-outbreak levels within a year (Taha 2007). The supply of poultry products may be disrupted temporarily because tens of millions of birds may die or be culled because of AI outbreaks, which are in this instance, to be exact, HPAI outbreaks.

From a trade perspective, changes in consumer demand translate into changes in the overall volume of imports, while the disruption of supplies affects bilateral flows by reallocating market shares to the advantage of AI-free countries. Nonetheless, despite the economic importance of AI outbreaks, we are interested in the policy effects of such outbreaks.

When estimating the gravity equation, further justifications are made in order to capture more comprehensive trade flow changes when AI outbreaks occur. Specifically, 1) we distinguish between HPAI and LPAI as AI outbreaks, given that the two types of AI outbreak have different infection and mortality rate on birds. We mainly focus on HPAI given the more frequent occurrence of such outbreaks and potentially larger impact; however, we also estimate the impact of LPAI outbreaks to consider whether LPAI, with its lower probability of infection, could have a smaller impact on trade flow, related NTM implementation, and NTMs related indirect trade impacts as well; 2) our research distinguish uncooked and cooked poultry products. Given uncooked products can be considered as intermediate-commodity as input and cooked products are usually considered as final products, and also the cooked and uncooked products may be affected by AI in different way, to distinguish them allows us to better identify if there are different impacts of AI outbreaks on these two products and if there are different trade policy impacts associated with them; 3) In addition to regress trade volume, we also apply the same model to trade value to reflect the potential price effects when AI outbreaks and when there are indirect policy impact; 4) to exactly measure the magnitude of AI outbreaks, instead of using the dummy of AI outbreaks, we also counted the number of AI cases and use the number to see its impact on trade and policy; 5) to disentangle the AI outbreak impacts in China and in importing countries, we also construct AI outbreak dummies for outbreak in China only, outbreak in partner counties only, and outbreaks in both simultaneously 6) We separate the sample into large import share and small import share countries to observe whether there are "big country" effects.

All these regression results are presented in the following section for discussion.

Estimation Results

Results of the impact of HPAI outbreaks on the poultry trade (entire sample)

This estimation is based on equation (2) from the prior section. The main results are summarized in Table 2. Because we use the MNPML estimators that follow linear exponential distribution, the estimated coefficients do not show marginal effects as opposed to semi-elasticity effects (Chen 2014). In order to make it easier to understand how each variable affects the dependent variable, we interpret the estimated coefficients in terms of incidence rate ratio (IRR); namely, the exponential value of the estimated coefficients. For all the results in this section, we present the original regression results of the MNPML estimators with corresponding IRR results in below parentheses.

[Insert Table 2]

From Table 2, we observe that in general, HPAI outbreaks in China do not have a significant impact on uncooked poultry volume and value or cooked poultry volume and value. HPAI outbreaks in partner countries negatively affect the uncooked and cooked poultry trade. The impact is significant for the uncooked poultry trade but not the cooked poultry trade. The overall negative effects of HPAI outbreaks in partner countries on the uncooked and cooked poultry trades (no matter whether they are significant or not) can be explained by consumers' expectations. When HPAI outbreaks occur in importing countries, consumers in importing countries become reluctant to consume poultry products, including imported products. Hence, demand for imports drops and thereby affects China's poultry exports negatively. Specifically, with regard to uncooked poultry trade volume, the exponential value of -1.282 is 0.277. Thus, when an HPAI outbreak occurs in a partner country, China's poultry exports (the market share of exports to a particular partner country in terms of total poultry exports) are 72.3% less in volume. When no HPAI outbreak occurs in a partner country, China's poultry exports are similarly 74.4% less in value. However, the negative effects are not significant for cooked poultry. This situation may occur because cooked products, with further processing, can be less affected by HPAI outbreaks. Rational consumers may consider cooked products as problem free in terms of AI.

The effects of the exporting country's (China's) GDP are not significant for uncooked and cooked poultry products. However, the effects of the GDPs of importing partner countries are significant. When an importing country's GDP level increases by one, China's uncooked poultry export volume share increases 1.855 times. Accounting for the price effect, the export value share increases 1.868 times. However, China's cooked poultry export volume share decreases 0.773 times. Accounting for the price effect, the export value share decreases 0.821 times. The different directions of importing countries' GDP impact on uncooked and cooked products may be because countries with higher GDP/income levels import more uncooked poultry products and fewer cooked products. By observing the real data scatter, this result is more similar to the general result. China's uncooked poultry products were mainly exported to lower income/less developed countries during the sample period. Among this group, the higher the income, the greater the amount of uncooked products they continued to import from China.

The effects of WTO membership for China and its importing trade partners are significant for the uncooked poultry trade but not for the cooked poultry trade, although both effects are positive. The positive effects are as expected because the WTO's target is to facilitate trade among member countries. When both China and an importing partner country are WTO members, the volume of uncooked poultry exports from China to the partner country increases by 2.855 times and the value increases by 2.930, accounting for price effects. The impact on the cooked poultry products' trade is on a smaller scale and insignificant. This may be because cooked products are more likely to face nontariff barriers such as private standards that do not really match the WTO regime.

The effects of having FTAs for China and importing trade partners are not significant for either uncooked or cooked poultry products. This may be because, in a different way to WTO membership, FTA content may focus on other commodity trades or service trades rather than agricultural, poultry commodities. Thus, having the same FTA may not necessarily affect the poultry trade significantly.

The effects of the circumstance whereby China and a trading partner country share a border are significant. If they share a border, the volume and value of uncooked poultry exports are much larger than if they do not share a border. The respective percentages are 828.1% and 845.9%. Uncooked poultry products tend to require a shorter transportation time; thus, a close location increases China's exports to a neighboring country. If China and a trading partner country share a border, the volume and value of cooked poultry exports from China are slightly smaller than if they do not share a border. The respective percentages are 98.8% and 98.2%, with just 1.2% and 1.8% decreases. There are 14 countries that have borders with China. Most poultry imports to these countries from China are uncooked products. This variable, and the effects on China's poultry exports, are quite specific in our case study.

The effects of distance are negative on both uncooked and cooked poultry exports from China and are significant with regard to the latter. The negative impacts follow the intuition that the larger the distance between China and an importing trade partner, the smaller the poultry trade flow from China to such a country. If the distance logarithm value increases by one unit, the volume of cooked poultry exports from China decreases 0.112 times and the export value from China decreases 0.121 times.

These results reflect the direct effects of HPAI outbreaks on China's poultry exports. Next, we capture the indirect effects of HPAI-induced NTMs on China's poultry exports.

Results of the impact of HPAI outbreaks on NTMs and the poultry trade (entire sample, two stages)

This estimation has two stages. Stage one adopts Probit regression for equation (3). The purpose is to capture the impact of AI outbreaks on NTMs, specifically the impact of HPAI outbreaks. With the predicted NTM results, we estimate the effect of HPAI outbreaks on the poultry trade at stage two using an MNPML estimator. The results are presented in Table 3. From the results, we summarize our observations as follows.

[Insert Table 3]

With regard to the results of the first stage Probit regression, we predict the probability of imposing NTMs. The effects of HPAI outbreaks in either China or importing partner countries do not significantly affect the predicted probability of imposing NTMs on the uncooked and cooked poultry product trades. The reasons why importing countries impose NTMs are complex. For example, outbreaks of HPAI, either domestically or in an exporting country, may not directly lead to NTMs. Further, there are 122 importing partner countries in our data sample. The heterogeneity of this many importing countries increases the complexity of the issue. Besides the *HPAI outbreak* variable, most variables do not have a significant impact on NTM appearance. Other variables have significant impacts in the first stage as follows.

The GDP of a partner country has a significant positive impact on the probability of imposing an NTM on the cooked poultry products trade. An increase in the GDP logarithm level of an importing partner country increases the predicted probability of imposing an NTM on cooked poultry exports from China. The NTMs of our study are SPS and TBT measures. These two NTMs are mainly concern product quality. Countries with higher incomes tend to be stricter about commodity quality and thus impose more NTMs on imported commodities. Cooked products that involve more processing are more likely to be assessed on quality and standardization issues. This approach may explain the positive coefficient of the variable.

Sharing a border with China decreases the predicted probability of imposing NTMs on uncooked poultry product exports from China. Sharing a border may reduce the trade friction of uncooked poultry products in terms of NTMs because of location and close, neighboring advantages. An increase in the logarithm distance between China and a partner country decreases the predicted probability of imposing NTMs on uncooked poultry product exports from China significantly. The farther the two countries are located from each other, the greater the possible reduction in trade friction with regard to uncooked poultry products in terms of SPS and TBT barriers.

If an NTM is imposed in a prior month, the predicted probability of imposing an NTM on both uncooked and cooked poultry product exports from China is larger. When an NTM has been implemented previously, it is easier to continue it or to impose a new NTM in terms of administrative and management costs and effort. One point to notice here is that having an NTM in a prior month has a larger impact on uncooked than cooked products. This may be because uncooked poultry products are relatively “fresher” compared with processed cooked products. Hence, the former are more sensitive to an NTM when an HPAI outbreak occurs. Without further product processing, HPAI outbreaks could affect uncooked products more directly over a longer period.

Based on the results of the second stage MNPML estimation, we observe very similar results as those in Table 2, which presents the results for the model without NTM policy impacts. The effects of the predicted probability of a partner country imposing an NTM are negative and significant on the value of uncooked poultry exports from China. Specifically, when an NTM is imposed, the value of uncooked poultry exports from China fall to 69.1% of the value that they have when an NTM is not imposed. Intuitively imposing an NTM increases trade costs; thus, trade value decreases. The effects of the same variable on uncooked exports volume, cooked exports volume, and cooked exports value are not significant. Besides the NTM variables, the variable $HPAI_p$ has significant negative impacts on the trade volume and value of uncooked exports. Indeed, volume falls to 29.1% and value falls to 26.8% of the volume and value that apply when there are no HPAI outbreaks in a partner country. These results are similar to those of Table 2. The variable $logGDP_p$ has a significant impact on all four dependent variables. It has a positive impact on uncooked exports (an increase of 1.937 times for volume and 1.952 times for value) and a negative impact on cooked exports (a decrease of 0.782 times for volume and 0.762 times for value). The variable *WTO* has positive and significant impacts on the volume and value of the uncooked trade, with a 20.883 times increase for volume and a 2.968 times increase for value. The variable *border* has positive significant impacts on the volume and value of the uncooked trade, with a 643.4% increase in volume and 647.8% increase in value compared with countries that do not share a border with China. The variable *border* has negative significant impacts on the volume and value of the cooked trade, with reductions to 98.8% in terms of volume and 98.1% in terms of value compared with countries that do not share a border with China. The variable *log distance* has negative and significant impacts on the volume and value of the cooked trade, with a decrease of 0.118 times in volume and 0.128 times in value when there is a one-unit increase in the variable.

The similarity of the results pattern to that of Table 2 implies that the predicted probability of imposing NTMs after HPAI outbreaks in either China or importing partner countries may not have a significant impact on poultry trade flows.

Results of different measures of AI outbreaks (entire sample, two stages)

In the prior estimation results of Tables 2 and 3, we use a dummy variable of *HPAI* (whether it occurs or not) as the measurement of AI outbreaks, given its higher frequency and greater impact. In this section, we use other measures of AI outbreaks to confirm whether our prior results are robust. We mainly focus on a two-stage estimation that captures the direct impact of AI and the indirect impact of NTM policy on the poultry trade. The results are shown in Table 4. For simplification, we only show the results of the main variables of interest; namely, the AI and NTM-related variables. The results of other variables are consistent and available upon request.

[Insert Table 4]

The first alternative AI measurement is the number of cases of AI outbreaks. The variables $Case_c$ and $Case_p$ represent the numbers of HPAI outbreaks in China and its importing partner countries respectively. From the first part of Table 4, we observe that the signs of the estimated coefficients are all consistent with those in Table 3. Specifically, looking at coefficient value and level of significance, we find the following points. First, the variable $Case_c$ has a negative significant impact on NTM_p. This result indicates that when the number of AI outbreaks in China increases, the predicted probability of partner countries imposing NTMs on cooked products decreases. This finding may be because of the difference between cooked and uncooked products. Uncooked poultry products are expected to experience a more immediate and direct shock when AI occurs. As relatively fresh agri-food products, uncooked products are directly affected by food safety concerns in terms of the imposition of NTMs. Instead, the best substitutes for uncooked poultry products are cooked ones. For example, after frozen uncooked chicken from Thailand was banned by the country's top importers after the AI outbreak in 2004, Thailand compensated for the loss by increasing cooked chicken meat exports to its import markets (Puthavathana 2006). This substitution effect may lead to an immediate drop in potential NTM impositions on cooked products when AI outbreaks increase.

Second, the variable $Case_p$ has a significant positive impact on the predicted probability of the imposition of an NTM by an importing partner country with regard to uncooked poultry exports from China. An increase of AI cases in a partner country increases the predicted probability of an NTM being imposed by the country. This may be because when an AI outbreak occurs domestically with an increase in cases, an importing partner country may be stricter about the quality of imported poultry products, especially uncooked ones. Such uncooked poultry products are more likely to be affected by an influenza virus or carry such a virus. The variable $HPAI_p$'s impact on NTM_p is not significant but has the same sign as in Table 3.

Third, the variable $Case_p$ has no significant impacts on the volume and value of the uncooked trade compared with Table 3's result. This may be because of the significant increase of NTM implementation on the uncooked trade. Lastly, the variable NTM_p has a significant negative impact on the value of the uncooked poultry trade at a slightly larger level. When an NTM is imposed by a partner country, the value of the uncooked trade decreases to 68.5% when the AI measurement is the number of cases as opposed to when the measurement is whether or not there is an HPAI outbreak (69.1%). Thus, when more detailed information such as the number of outbreak cases is provided, the NTM impact on trade value can be at a very slightly larger level.

The second alternative AI measure is LPAI outbreaks. Compared with HPAI outbreaks, LPAI outbreaks are less frequent during the sample period throughout China and the 122 importing countries. In addition, in contrast to HPAI, LPAI outbreaks are not fatal to birds. In order to check the robustness of our model, we conduct the same estimation using LPAI outbreak dummy variables. If we focus on the significant results from the second part of Table 4, we observe the consistency of the coefficients' signs. Some coefficient value changes are observed. The variable $LPAI_p$ has a larger negative impact on the volume and value of the uncooked poultry trade. This may be because although LPAI outbreaks are not as fatal to poultry as HPAI outbreaks, the possibility of contagion and the long-lasting effects arouse more anxiety in importing countries. Hence, imported uncooked poultry products may experience a larger decrease in volume and value than with HPAI outbreaks (Taha 2007; WTO 2016).

We also differentiate between HPAI outbreaks that occur only in China, only in partner countries, or in China and partner countries simultaneously. The results are in general consistent with those of Table 3 in terms of the coefficient signs. HPAI outbreaks that occur only in China do not have a significant impact on any of the four dependent variables, although HPAI outbreaks in partner countries do have a significant impact. One interesting change is that when HPAI outbreaks occur simultaneously in China and partner countries, this situation significantly increases the predicted probability of partner countries imposing NTMs. Simultaneous outbreaks of HPAI tend to increase importing partner countries' NTM implementation in order to prevent further spreading of the influenza in terms of poultry and human health.

Moreover, contagious diseases such as AI always have some lag impacts that could affect consumption/importing decisions. These lag impacts may last for up to a year (Taha 2007). We include lag variables for both $HPAI_c$ and $HPAI_p$ in our estimation. The fourth part of Table 4 summarizes the results. The results of our focus variables, $HPAI_c$, $HPAI_p$, and NTM_p, are consistent with Table 3. Interesting observations are also identified among the lag variables. We observe that in terms of NTM imposition, cooked poultry products are more time sensitive (faster) in response to HPAI outbreaks than uncooked products. When HPAI outbreaks occur in China or partner countries, although they do not significantly affect the predicted probability of NTM impositions by partner countries in the same month, after two or three months, the predicted probability of NTM impositions by partner countries increases for cooked products. This finding does not contradict the results from the estimation based on the number of cases. This estimation captures the immediate reaction of the variable NTM_p after AI outbreaks. However, after approximately seven months, the predicted probability of NTM impositions by partner countries increases for cooked products. Uncooked products seem to have a longer lag effect in terms of HPAI outbreaks (whether they apply to importing or exporting countries) compared with cooked products. This result may be because of the difference in uncooked and cooked products: The former is more similar to fresh agricultural products, while the latter is closer to processed manufacturing products. Agricultural products usually involve contracts that are signed before harvesting in order to prevent potential production risk. They also have fewer alternative products in the case of AI outbreaks. Thus, it may be difficult for importers to find alternatives for fresh agricultural products. However, as with other manufactured products, contracts for cooked poultry products may last for shorter periods. Moreover, it is easier for importers to find processed food alternatives. Thus, the early imposition of NTMs on cooked products may not cause too great a cost for the countries that impose them. Quality and food safety concerns have greater priority for importing partner countries in such instances.

In order to check the robustness of the results further because of the prevalence of zeros in the trade data, we aggregate the monthly data into quarterly data and conduct the same two-stage IV MNPML estimation. The results are shown in the last part of Table 4. With quarterly data, an increase in the variable $HPAI_c$ significantly increases the predicted probability of partner countries imposing NTMs on uncooked products, while it significantly decreases the predicted probability of partner countries imposing NTMs on cooked products. This result is consistent with the prior results. An increase in HPAI outbreaks in China causes more nontariff friction for the uncooked poultry market and less immediate nontariff friction (the friction increases later) in the cooked poultry market. In addition, the effects of the variable $HPAI_p$ are smaller compared with the monthly data estimation in terms of impact range and significance level (the variable only affects the volume of the uncooked poultry trade significantly); however, the impact direction is still consistent. This may be because of the longer period, during which some of the impact of an AI outbreak on trade flows may be canceled out.

Results of top importers and the rest of the countries (two samples, IV MNPML)

By comparing the results in Tables 3 and 4, we find the significance of the direct impact of AI outbreaks on trade flows and the indirect impact of NTMs on trade are in general consistent, no matter how we change the main AI related variables. However, there are slight variations in terms of significance level and impact degree. In order to identify potential reasons, we separate the full sample into China's top 10 importing partner countries and the rest for further estimation and comparison. The rankings (based on China's export volumes to partner countries during the sample period) of importers for both uncooked and cooked products are listed in the appendix, Tables 4 and 5. The results for the top 10 importers and the rest are shown in Table 5 with the IRR results.

[Insert Table 5]

With regard to the uncooked poultry trade, comparing the results to the main ones in Table 3, the differences are as follows. First, the significant impacts of the variable $HPAI_p$ on the volume and value of the uncooked trade disappear for both the top 10 group and the others. Second, the variable $HPAI_c$ has a significant negative impact on NTM_p for the others. Thus, an increase in HPAI outbreaks in China decreases the predicted probability of the other importing partner countries imposing NTMs. Third, a higher probability of imposing NTMs reduces the volume and value of uncooked poultry imports for the other countries but not for the top 10 countries. Specifically, when an NTM is imposed, trade volume for the other countries falls to 34.8%. When no NTM is imposed, trade value for the other countries falls to 34.9%. This difference implies that the other countries are dominant in terms of the impact of the variable NTM_p on uncooked poultry trade flows in the full sample.

With regard to the cooked poultry trade, comparing the results to the main ones in Table 3, there is only one difference. The variable $HPAI_c$ has a significant negative impact on NTM_p for the top 10 group. Thus, an increase in HPAI outbreaks in China decreases the predicted probability of the top 10 importing partner countries imposing NTMs. This result is consistent with the prior results in Tables 3 and 4.

In addition to all the robustness checks using the same estimation, we adopt Tobit regression for all the given variables in order to conduct a further round of checks. The results are consistent in terms of coefficient signs and significance, except for some difference in the coefficient values. The results from the Tobit regression are available upon request.

[Insert Table 6]

Conclusion

We use monthly poultry export data from China to all its trading partner countries in order to identify the direct impact of AI outbreaks and the indirect impact of AI-induced NTMs on trade flow. With various justifications and robustness checks on the model, we obtain interesting results. Based on the analysis, we offer the following important conclusions.

First, in a different result from prior studies (Peterson and Orden 2005; Djunaidi and Djunaidi 2007) regarding the impact of AI outbreaks on trade flow, we find that in the context of AI outbreaks in China, exporting countries may not significantly affect the poultry trade. Instead, AI outbreaks in importing countries more significantly reduce such countries' uncooked poultry imports. This result is fairly consistent throughout the variations but is particularly large in the case of LPAI outbreaks. The reason is mainly because consumers' expectations of imported poultry products are negatively affected by domestic AI outbreaks.

Second, although AI outbreaks in China do not affect trade flow directly, a greater number of AI outbreaks in China may reduce the probability of importing partner countries imposing

NTMs on cooked product imports from China. This immediate and temporary result is because cooked poultry products are processed food. Such food may be less affected by AI outbreaks compared with freshly produced agricultural products. Hence, fewer food safety and quality concerns may be raised. Moreover, cooked poultry products can serve to some extent as substitute products for uncooked poultry products. However, after a certain period following an initial AI outbreak, importing countries impose NTMs on cooked products. This is particularly true when importing countries are developed and high-income countries that tend to import more processed products and are strict about NTMs in the long term.

Third, when NTMs are imposed because of AI outbreaks, the uncooked poultry products trade decreases. This is because NTMs mainly target agricultural products such as uncooked products rather than processed products such as cooked products. This impact is particularly significant mainly because poultry importers have a smaller market share of China’s uncooked poultry exports. With regard to China, most of these importing countries are developed and high-income countries.

Last, with regard to China’s poultry exports, developed and high-income countries mainly import cooked products. Such countries are strict about imports of agricultural products (uncooked poultry) and processed (cooked) products. Indeed, NTMs are mainly imposed by such developed countries. This finding is consistent with the literature on agricultural exports from developing countries (Jongwanich 2009). Such an export pattern for China’s poultry products is also consistent with Jaud et al.’s (2013) study on supplier concentration. With the risk of AI outbreaks that affect food safety, the less risky exports of cooked poultry products from China are mainly shipped to developed and high-income countries. Although there is still the risk of strict NTMs when AI outbreaks occur, the trade/business relationship between China and importing countries is relatively stable. Indeed, NTMs' negative impact on cooked poultry imports from China after AI outbreaks is not significant.

Based on the foregoing findings, some policy implications can be derived. For the agricultural exporters of developing countries, moving up the global value chain by exporting more processed products can provide better access to developed countries' markets. Although there may be more NTMs with stricter standards and quality requirements, developing countries' exporters could also benefit from a positive spillover. Once an export relationship is established, this can be stable and subject to fewer risks from external shocks such as AI outbreaks.

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Figure and Tables

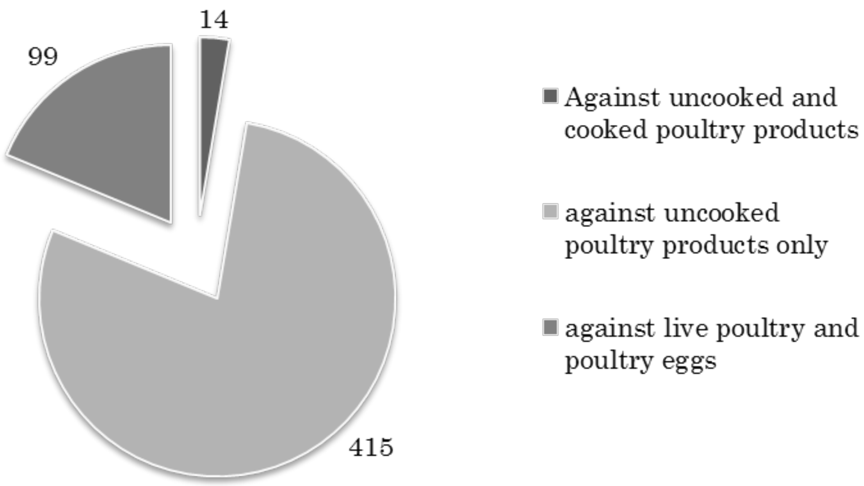

Figure 1 Composition of AI-related SPS measures

Table 1. Variables and Description

Variables	Description	Uncooked		Cooked	
		Mean	S.D.	Mean	S.D.
Trade flows					
Volume	China's export quantity (tons)	30.500	171.489	89.415	835.756
Value	China's export value (ten thousand USD dollars)	6.396	41.449	35.090	329.008
Avian Influenza					
$HPAI_C$	$HPAI_C$ = 1 if highly pathogenic avian influenza (HPAI) outbreaks occurred in China	0.213	0.409	0.213	0.409
$HPAI_P$	$HPAI_P$ = 1 if highly pathogenic avian influenza (HPAI) outbreaks occurred in China's trading partners	0.053	0.224	0.030	0.170
Measures					
NTM_p	NTM_p = 1 if China's trading partners reported new NTMs including SPS and TBT measures to the WTO	0.586	0.235	0.035	0.184
Other Variables					
GDP_C	GDP of China measured in real terms as of 2000 US$ prices (ten thousand USD dollars)	0.412	0.175	0.412	0.175
GDP_p	GDP of China's trading partner measured in real terms at 2000 US$ prices (ten thousand USD dollars)	0.719	1.130	2.127	2.186
WTO	Dummy variable, 1 = China's trading partner is a WTO member, 0 = otherwise	0.679	0.467	0.853	0.354
FTA	Dummy variable, 1 = China and its trading partner are part of the same FTA, 0 = otherwise	0.237	0.426	0.167	0.373
Border	Dummy variable, 1 = China and its trading partner share a land border, 0 = otherwise	0.279	0.449	0.076	0.265
Distance	Distance of capitals between China and its trading partner (thousand kilometers)	5.744	3.236	7.880	3.542

Table 2. Estimated Impact of HPAI on China's Poultry Exports (MNPML)

Variables	Uncooked Poultry		Cooked Poultry	
	π Volume	π Value	π Volume	π Value
$HPAI_C$	0.023	0.023	-0.028	-0.031
	(1.023)	(1.023)	(0.972)	(0.969)
$HPAI_P$	-1.282**	-1.364***	-0.081	-0.112
	(0.277)	(0.256)	(0.922)	(0.894)
Log GDP_C	-0.094	-0.097	-0.035	-0.046
	(0.910)	(0.908)	(0.966)	(0.955)
Log GDP_P	0.618**	0.625**	-0.258***	-0.197**
	(1.855)	(1.868)	(0.773)	(0.821)
WTO	1.049***	1.075***	0.255	0.252
	(2.855)	(2.930)	(1.290)	(1.287)
FTA	0.186	0.213	-0.369	-0.488
	(1.204)	(1.237)	(0.691)	(0.614)
Border	2.228***	2.247***	-4.452***	-4.016***
	(9.281)	(9.459)	(0.012)	(0.018)
Log distance	-0.023	-0.023	-2.187***	-2.113***
	(0.977)	(0.977)	(0.112)	(0.121)
Constant	-4.283***	-4.315***	-0.148	-0.260
	(0.014)	(0.013)	(0.862)	(0.771)
Constant lnalpha	0.725***	0.738***	1.193***	1.207***
	(2.065)	(2.092)	(3.297)	(3.343)
Year fixed effects	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes
Product-country random effects	Yes	Yes	Yes	Yes
Wald chi2	237.55***	229.69***	350.75***	362.62***
LR test of alpha = 0	554.78***	570.15***	1225.41***	1209.17***
Hausman Test	56.19***	55.47***	9.24	1.02
Observations	11,988	11,988	22,680	22,680

Note: (1) *, **, and *** represent 10%, 5%, and 1% significance levels respectively.

(2) Year fixed effects are controlled by eight year-dummies for 2006–2013. The dummy for 2005 is dropped. Month fixed effects are controlled by eleven month-dummies for February to December. The dummy for January is dropped.

(3) The IRR results of the MNPML estimator are shown in the parentheses.

Table 3. Estimated Impact of HPAI on China's Poultry Exports (Two Steps)

Variables	Uncooked			Cooked		
	1st stage dependent: NTM_P (Probit)	*2nd stage dependent:* π Volume (MNPML)	*2nd stage dependent:* π Value (MNPML)	*1st stage dependent:* NTM_P (Probit)	*2nd stage dependent:* π Volume (MNPML)	*2nd stage dependent:* π Value (MNPML)
$HPAI_C$	-0.084	-0.007	-0.009	-0.041	-0.014	-0.014
		(0.993)	(0.991)		(0.986)	(0.986)
$HPAI_P$	0.132	-1.236**	-1.316***	0.057	-0.121	-0.164
		(0.291)	(0.268)		(0.886)	(0.849)
NTM_P	——	-0.354	-0.369*	——	0.258	0.326
		(0.702)	(0.691)		(1.294)	(1.385)
Log GDP_C	0.045	-0.079	-0.080	0.070	-0.052	-0.068
		(0.924)	(0.923)		(0.949)	(0.934)
Log GDP_P	0.122	0.661**	0.669**	0.201***	-0.317***	-0.272***
		(1.937)	(1.952)		(0.728)	(0.762)
WTO	—	1.059***	1.088***	—	0.263	0.260
		(2.883)	(2.968)		(1.301)	(1.297)
FTA	-0.078	0.148	0.173	0.190	-0.448	-0.577
		(1.160)	(1.189)		(0.639)	(0.562)
Border	-0.619**	2.006**	2.012**	-0.242	-4.389***	-3.945***
		(7.434)	(7.478)		(0.012)	(0.019)
Log distance	-0.497**	-0.197	-0.206	-0.215	-2.136***	-2.053***
		(0.821)	(0.814)		(0.118)	(0.128)
Constant	-0.547	-4.473***	-4.511***	-2.042***	0.395	0.433
		(0.011)	(0.011)		(1.484)	(1.542)
Constant lnalpha		0.727***	0.739***		1.195***	1.207***
		(2.069)	(2.094)		(3.304)	(3.343)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Product-country random effects	Yes	Yes	Yes	Yes	Yes	Yes
$NTM_P(-1)$	0.703***	——	——	0.581***	——	——
lnsig2u	-0.543**			0.075		
LR test of rho=0	457.050***			1065.070***		
Observations		11,877	11,877		22,470	22,470
Wald chi2	205.860***	233.88***	227.90***	370.040***	354.08***	422.20***
LR test of alpha=0		554.67***	569.95***		1207.92***	1192.54***
Hausman chi2		78.71***	82.18***		2.05	2.99

Note: (1) *, **, and *** represent 10%, 5%, and 1% significance levels respectively.
(2) $NTM_P(-1)$ represents NTM_P that lags for one phase.
(3) The IRR results of the MNPML estimator are shown in the parentheses.

Table 4. Different Measures of AI (Two Steps)

Variables	Uncooked			Cooked		
	1st stage dependent: NTM_P (Probit)	*2nd stage dependent:* π_{Volume} (MNPML)	*2nd stage dependent:* π_{Value} (MNPML)	*1st stage dependent:* NTM_P (Probit)	*2nd stage dependent:* π_{Volume} (MNPML)	*2nd stage dependent:* π_{Value} (MNPML)
Number of cases of HPAI outbreaks						
$Case_C$	-0.056	-0.013	-0.014	-0.071*	0.003	0.007
		(0.987)	(0.986)		(1.003)	(1.007)
$Case_P$	0.006**	-0.279	-0.389	0.003	-0.008	-0.009
		(0.757)	(0.678)		(0.992)	(0.991)
NTM_P	—	-0.363	-0.378*	—	0.216	0.268
		(0.696)	(0.685)		(1.241)	(1.307)
$NTM_P(-1)$	0.692***	—	—	0.576***	—	—
Low pathogenic avian influenza (LPAI)						
$LPAI_C$	0.173	0.160	0.163	-0.133	0.021	0.027
		(1.174)	(1.177)		(1.021)	(1.027)
$LPAI_P$	-0.315	-17.294***	-18.286***	0.083	-0.002	-0.014
		(0.000)	(0.000)		(0.998)	(0.986)
NTM_P	—	-0.364*	-0.378*	—	0.212	0.263
		(0.695)	(0.685)		(1.236)	(1.301)
$NTM_P(-1)$	0.703***	—	—	0.585***	—	—
Whether HPAI occurred in China and its trading partners simultaneously						
$HPAI_{C1\text{-}P0}$	-0.029	0.028	0.024	-0.027	-0.015	-0.015
		(1.028)	(1.024)		(0.985)	(0.985)
$HPAI_{C1\text{-}P1}$	—	-19.049***	-20.072***	-0.314	-0.473	-0.566
		(0.000)	(0.000)		(0.623)	(0.568)
$HPAI_{C0\text{-}P1}$	0.317**	-0.898*	-0.980**	0.118	-0.125	-0.169
		(0.407)	(0.375)		(0.882)	(0.845)
NTM_P	—	-0.353*	-0.366*	—	0.255	0.322
		(0.703)	(0.694)		(1.290)	(1.380)
$NTM_P(-1)$	0.711***	—	—	0.579***	—	—
Lagging effects of HPAI						
$HPAI_C$	-0.030	-0.072	-0.074	-0.037	-0.009	-0.015
		(0.931)	(0.929)		(0.991)	(0.985)
$HPAI_C(-1)$	0.028	-0.007	-0.007	0.047	-0.080	-0.086*
		(0.993)	(0.993)		(0.923)	(0.918)
$HPAI_C(-2)$	-0.077	0.010	0.008	0.269***	-0.028	-0.041
		(1.010)	(1.008)		(0.972)	(0.960)
$HPAI_C(-3)$	0.136	0.084	0.088	0.266***	0.030	0.019
		(1.088)	(1.092)		(1.030)	(1.019)
$HPAI_C(-4)$	0.137	0.044	0.047	0.047	-0.021	-0.025
		(1.045)	(1.048)		(0.979)	(0.975)
$HPAI_C(-5)$	-0.061	-0.169	-0.171	0.126*	0.001	-0.012

		(0.845)	(0.843)		(1.001)	(0.988)
$HPAI_C(-6)$	-0.107	-0.182	-0.187	0.191***	-0.057	-0.068
		(0.834)	(0.829)		(0.945)	(0.934)
$HPAI_C(-7)$	0.252***	0.005	0.006	0.159**	-0.047	-0.057
		(1.005)	(1.006)		(0.954)	(0.945)
$HPAI_C(-8)$	0.131	-0.076	-0.073	-0.014	-0.020	-0.021
		(0.927)	(0.930)		(0.980)	(0.979)
$HPAI_C(-9)$	0.228***	-0.029	-0.024	-0.065	-0.020	-0.018
		(0.971)	(0.976)		(0.980)	(0.982)
$HPAI_C(-10)$	-0.100	-0.059	-0.059	0.219***	-0.031	-0.044
		(0.943)	(0.943)		(0.969)	(0.957)
$HPAI_C(-11)$	0.074	-0.060	-0.057	0.116	-0.027	-0.035
		(0.942)	(0.945)		(0.973)	(0.966)
$HPAI_C(-12)$	-0.103	-0.045	-0.049	-0.158*	0.048	0.050
		(0.956)	(0.952)		(1.049)	(1.051)
$HPAI_P$	0.177	-1.435**	-1.546**	-0.028	-0.096	-0.137
		(0.238)	(0.213)		(0.908)	(0.872)
$HPAI_P(-1)$	0.266	-0.038	-0.046	0.195	-0.072	-0.081
		(0.963)	(0.955)		(0.931)	(0.922)
$HPAI_P(-2)$	-0.232	-0.028	-0.064	-0.110	-0.083	-0.095
		(0.972)	(0.938)		(0.920)	(0.909)
$HPAI_P(-3)$	-0.149	-0.383	-0.451	-0.390**	0.144	0.148
		(0.682)	(0.637)		(1.155)	(1.160)
$HPAI_P(-4)$	0.063	0.301	0.329	0.267	-0.209	-0.240
		(1.351)	(1.390)		(0.811)	(0.787)
$HPAI_P(-5)$	-0.254	-0.336	-0.348	0.112	-0.062	-0.072
		(0.715)	(0.706)		(0.940)	(0.931)
$HPAI_P(-6)$	-0.160	-0.128	-0.127	0.008	0.116	0.094
		(0.880)	(0.881)		(1.123)	(1.099)
$HPAI_P(-7)$	0.554***	0.108	0.109	-0.383**	-0.069	-0.060
		(1.114)	(1.115)		(0.933)	(0.942)
$HPAI_P(-8)$	-0.518**	-0.200	-0.246	-0.396*	0.162	0.169
		(0.819)	(0.782)		(1.176)	(1.184)
$HPAI_P(-9)$	0.010	-0.029	-0.079	-0.024	-0.045	-0.036
		(0.971)	(0.924)		(0.956)	(0.965)
$HPAI_P(-10)$	-0.303	-0.178	-0.269	-0.441**	0.067	0.063
		(0.837)	(0.764)		(1.069)	(1.065)
$HPAI_P(-11)$	-0.121	-0.090	-0.160	0.400**	-0.112	-0.148
		(0.914)	(0.852)		(0.894)	(0.862)
$HPAI_P(-12)$	0.245	0.058	0.044	0.065	-0.184	-0.202
		(1.060)	(1.045)		(0.832)	(0.817)
NTM_P	—	-0.197	-0.217	—	0.204	0.249
		(0.821)	(0.805)		(1.226)	(1.283)
$NTM_P(-1)$	0.656***	—	—	0.569***	—	—

Quarterly data						
$HPAI_C$	0.201*	0.134	0.135	-0.184**	-0.027	-0.016
		(1.143)	(1.145)		(0.973)	(0.984)
$HPAI_P$	0.176	-0.971*	-0.996	0.193	-0.091	-0.145
		(0.379)	(0.369)		(0.913)	(0.865)
NTM_P	—	-0.159	-0.170	—	-0.025	0.021
		(0.853)	(0.844)		(0.975)	(1.021)
$NTM_P(-1)$	0.724***	—	—	0.906***	—	—

Note: (1) ∗, ∗∗, and ∗∗∗ represent 10%, 5%, and 1% significance levels respectively.

(2) *$NTM_P(-1)$* represents NTM_P that lags for one phase.

(3) The IRR results of the MNPML estimator are are shown in the parentheses.

Table 5. Contrast Between the Top 10 Importers and the Rest (Two Steps)

Variables	Top 10			The Rest		
	1st stage dependent: NTM$_P$ (Probit)	*2nd stage dependent:* π $_{Volume}$ (MNPML)	*2nd stage dependent:* π $_{Value}$ (MNPML)	*1st stage dependent:* NTM$_P$ (Probit)	*2nd stage dependent:* π $_{Volume}$ (MNPML)	*2nd stage dependent:* π $_{Value}$ (MNPML)
Uncooked						
$HPAI_C$	0.043	0.077	0.082	-0.163*	-0.362	-0.384
		(1.080)	(1.085)		(0.696)	(0.681)
$HPAI_P$	—	-0.439	-0.400	0.197	-0.632	-0.753
		(0.645)	(0.670)		(0.532)	(0.471)
NTM_P	—	-0.260	-0.266	—	-1.055*	-1.053*
		(0.771)	(0.766)		(0.348)	(0.349)
$NTM_P(-1)$	1.074***	—	—	0.515***	—	—
Cooked						
$HPAI_C$	-0.187*	0.070	0.081	0.044	-0.063	-0.061
		(1.073)	(1.084)		(0.939)	(0.941)
$HPAI_P$	0.044	-0.048	-0.075	-0.082	-0.553	-0.581
		(0.953)	(0.928)		(0.575)	(0.559)
NTM_P	—	0.334	0.402	—	-1.303	-1.581
		(1.397)	(1.495)		(0.272)	(0.206)
$NTM_P(-1)$	0.553***	—	—	0.390***	—	—

Note: (1) ∗, ∗∗, and ∗∗∗ represent 10%, 5%, and 1% significance levels respectively.

(2) $NTM_P(-1)$ represents NTM$_P$ that lags for one phase.

(3) The IRR results of the MNPML estimator are shown in the parentheses.

Table 6. Estimated Impact of HPAI on China's Poultry Exports (Two Steps)

Variables	Uncooked			Cooked		
	1st stage dependent: NTM_P (Probit)	*2nd stage dependent:* Log Volume (Tobit)	*2nd stage dependent:* Log Value (Tobit)	*1st stage dependent:* NTM_P (Probit)	*2nd stage dependent:* Log Volume (Tobit)	*2nd stage dependent:* Log Value (Tobit)
$HPAI_C$	-0.084	-0.407	-0.399	-0.041	-0.141	-0.152
		(0.666)	(0.671)		(0.868)	(0.859)
$HPAI_P$	0.132	-2.768**	-2.860**	0.057	-2.673***	-2.709***
		(0.063)	(0.057)		(0.069)	(0.067)
NTM_P	——	0.470	0.503	——	1.451	1.746
		(1.600)	(1.654)		(4.267)	(5.732)
Log GDP_C	0.045	-5.160***	-5.203***	0.070	2.803***	3.244***
		(0.006)	(0.006)		(16.494)	(25.636)
Log GDP_P	0.122	5.655***	5.921***	0.201***	-1.795***	-1.947***
		(285.716)	(372.784)		(0.166)	(0.143)
WTO	—	6.046***	6.273***	—	1.818	2.046
		(422.420)	(530.065)		(6.160)	(7.737)
FTA	-0.078	-4.581**	-4.697**	0.190	-0.734	-1.002
		(0.010)	(0.009)		(0.480)	(0.367)
Border	-0.619**	10.950***	11.360***	-0.242	-14.445***	-15.85***
		(56954.045)	(85819.368)		(0.000)	(0.000)
Log distance	-0.497**	-0.011	-0.055	-0.215	-7.404***	-8.190***
		(0.989)	(0.947)		(0.001)	(0.000)
Constant	-0.547	-17.340***	-17.850***	-2.042***	8.202**	9.420**
		(0.000)	(0.000)		(3648.239)	(12332.582)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Product-country random effects	Yes	Yes	Yes	Yes	Yes	Yes
$NTM_P(-1)$	0.703***	——	——	0.581***	——	——
lnsig2u	-0.543**			0.075		
sigma_e		11.69***	12.24***		9.042***	10.08***
sigma_u		12.37***	12.86***		9.074***	10.07***
LR test of sigma_u=0		3149.71***	3155.09***		6298.40***	6245.38***
Wald chi2	205.860***	252.690***	252.780***	370.040***	343.330***	352.970***
LR test of rho=0	457.050***			1065.070***		
Hausman Test		0.080	-0.730		1.810	2.470

Note: (1) *, **, and *** represent 10%, 5%, and 1% significance levels respectively.

(2)*$NTM_P(-1)$* represents NTM_P that lags for one phase.

(3) The IRR results of the MNPML estimator are shown in the parentheses.

Appendix

Appendix, Table 1. HS Codes and Poultry Article Information

HS code	Article Information
0207	***Meat and edible offal, of the poultry of heading 01.05, fresh, chilled, or frozen:***
02071	**Of fowls of the species Gallus domesticus**
02071100	Poultry not cut in pieces, fresh or chilled
02071200	Poultry not cut in pieces, frozen
02071311	Cuts with bones, fresh or chilled
02071319	Other cuts, fresh or chilled
02071411	Cuts with bones, frozen
02071419	Cuts without bones, frozen
02071421	Chicken wings, frozen
02071422	Chicken claw, frozen
02071429	Other offal, frozen
02072	**Of turkeys**
02072400	Not cut in pieces, fresh or chilled
02072500	Not cut in pieces, frozen
02072700	Cuts and offal, frozen
02073	**Of ducks, geese, or guinea fowls:**
02073210	Ducks not cut in pieces, fresh or chilled
02073220	Geese not cut in pieces, fresh or chilled
02073310	Ducks not cut in pieces, frozen
02073320	Geese not cut in pieces, frozen
02073400	Fatty livers of geese or ducks, fresh or chilled
02073510	Cuts and offal, fresh or chilled of ducks
02073610	Cuts and offal, frozen of ducks
02073620	Cuts and offal, frozen of geese
1602	***Other Prepared or preserved meat, meat offal, or blood:***
16023	**Of poultry of heading 01.05:**
160231	**Of turkeys**
16023100	Meat and offal
160232	**Of fowls of the species Gallus domesticus**
16023210	Canned chicken
16023291	Chicken breast meat
16023292	Dark meat
16023299	Other
160239	**Other**
16023910	Other canned meat and offal
16023991	Other prepared or preserved duck
16023999	Other prepared or preserved meat

Appendix, Table 2. Number of Countries that Import Poultry from China at the Eight-Digit HS Level

Uncooked Poultry		Cooked Poultry	
HS codes	No. of Countries	HS codes	No. of Countries
02071200	3	16023100	4
02071411	8	16023210	66
02071419	51	16023291	25
02071421	3	16023292	18
02071422	1	16023299	32
02071429	4	16023910	27
02072700	1	16023991	35
02073210	1	16023999	3
02073310	17		
02073320	1		
02073610	21		

Appendix, Table 3. New Cases of HPAI Outbreaks Across the World: NTMs Against Uncooked and Cooked Poultry Products and the Percentage of World Uncooked and Cooked Poultry Exports

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
New Outbreaks	213	1686	944	533	114	119	431	204	185	244	1790
NTMs	86	123	111	175	140	124	186	127	159	113	128
Uncooked (%)	87.91	87.76	87.70	88.03	88.17	88.19	87.77	87.86	87.56	87.95	87.25
Cooked (%)	12.09	12.24	12.30	11.97	11.83	11.81	12.23	12.14	12.44	12.05	12.75

Appendix, Table 4. Countries Importing Uncooked Poultry from China During 2005–13

Country	Trade Quantity (kg)	Percent age (%)	Cumulative Percentage	Cases of HPAI Outbreaks	Cases of LPAI Outbreaks	SPS	TBT
Malaysia	133876312	36.615	36.615	6	0	1	2
Kyrgyzstan	51208696	14.005	50.620	0	0	0	1
Bahrain	47476236	12.985	63.605	0	0	6	77
Iraq	21122242	5.777	69.382	6	0	0	0
Georgia	12499716	3.419	72.800	1	0	0	2
Azerbaijan	9859598	2.697	75.497	12	0	0	0
Afghan	9473202	2.591	78.088	22	0	0	0
Armenia	8336145	2.280	80.368	0	0	3	2
Moldova	8257985	2.259	82.626	0	0	0	1
Albania	6720252	1.838	84.464	3	0	43	1
Korea (Dem.)	6150616	1.682	86.147	4	0	0	0
Netherlands Antilles	5936432	1.624	87.770	0	0	0	0
Somalia	5897112	1.613	89.383	0	0	0	0
United Arab Emirates	5778598	1.580	90.963	0	0	15	20
Philippines	4680885	1.280	92.244	0	0	82	1
Aruba	2733775	0.748	92.991	0	0	0	0
Mozambique	2591967	0.709	93.700	0	0	0	0
Mongolia	2394255	0.655	94.355	8	0	0	1
Kenya	2043272	0.559	94.914	0	0	18	10
Maldives	1796034	0.491	95.405	0	0	0	0
Kazakhstan	1608497	0.440	95.845	2	0	0	0
Vietnam	1437706	0.393	96.238	362	1	2	0
Jordan	1401728	0.383	96.622	1	0	5	0
Netherlands	1340780	0.367	96.988	0	13	1	2
Uzbekistan	1317037	0.360	97.349	0	0	0	0
Tajikistan	1309484	0.358	97.707	0	0	0	0
Lithuania	917940	0.251	97.958	0	0	0	0
Angola	837518	0.229	98.187	0	0	0	0
Indonesia	631877	0.173	98.360	24	0	4	0
Turkey	608916	0.167	98.526	220	0	2	2
Papua New Guinea	604212	0.165	98.691	0	0	0	0
Yugoslavia	600200	0.164	98.856	0	0	0	0
Congo (Dem.)	509770	0.139	98.995	0	0	0	0
Cambodia	503512	0.138	99.133	22	0	0	0
Pakistan	467912	0.128	99.261	51	0	0	5
Russian Federation	429428	0.117	99.378	151	0	7	0
Iran	395092	0.108	99.486	5	0	0	0
Ukraine	379154	0.104	99.590	45	0	20	1
Thailand	267624	0.073	99.663	9	0	34	8

Greece	204000	0.056	99.719	15	0	0	0
Montenegro	184032	0.050	99.769	0	0	0	0
Egypt	146920	0.040	99.809	1086	0	6	0
Japan	111725	0.031	99.840	81	7	52	3
Tanzania	103500	0.028	99.868	0	0	0	1
Liberia	96192	0.026	99.895	0	0	0	0
Oman	72800	0.020	99.914	0	0	15	4
Bahamas	51960	0.014	99.929	0	0	0	0
Trinidad and Tobago	46900	0.013	99.941	0	0	0	0
Algeria	25800	0.007	99.949	0	0	0	0
Korea (Rep.)	25726	0.007	99.956	98	15	33	11
India	25443	0.007	99.963	102	0	5	0
Former Yug. Rep.of Macedonia	25200	0.007	99.969	0	0	2	0
Singapore	25010	0.007	99.976	0	0	0	0
Bosnia and Herzegovina	25008	0.007	99.983	1	0	0	0
Syria	25000	0.007	99.990	0	0	0	0
Lebanon	20180	0.006	99.995	0	0	0	0
Kiribati	9696	0.003	99.998	0	0	0	0
United States	4000	0.001	99.999	0	10	40	69
Myanmar	3000	0.001	100.000	108	0	0	0
Total	365633809			2445	46	396	224

Appendix, Table 5. Countries Importing Cooked Poultry from China During 2005–13

Country	Trade Quantity (kg)	Percent age (%)	Cumulative Percentage	Cases of HPAI Outbreaks	Cases of LPAI Outbreaks	SPS	TBT
Japan	1820319232	89.763	89.763	81	7	0	3
Korea (Rep.)	72608232	3.580	93.343	98	15	0	13
United Kingdom	34254248	1.689	95.032	7	2	0	0
Netherlands	21761074	1.073	96.105	0	13	0	2
Germany	16823078	0.830	96.935	434	71	0	0
Belgium	13292757	0.655	97.590	0	2	0	0
United States	7704160	0.380	97.970	0	10	17	67
Malaysia	6018060	0.297	98.267	6	0	0	2
Singapore	5651620	0.279	98.546	0	0	0	0
Ireland	4965385	0.245	98.791	0	1	1	0
Papua New Guinea	3166365	0.156	98.947	0	0	0	0
South Africa	2756226	0.136	99.083	74	49	0	7
Denmark	2238220	0.110	99.193	27	7	0	0
Mali	2187284	0.108	99.301	0	0	3	0
Pakistan	2134233	0.105	99.406	51	0	0	5
Bahrain	2092527	0.103	99.509	0	0	5	76
Mauritius	1418188	0.070	99.579	0	0	0	0
Solomon Islands	930482	0.046	99.625	0	0	0	0
Vanuatu	852119	0.042	99.667	0	0	0	0
Spain	810140	0.040	99.707	2	2	0	0
Liberia	798482	0.039	99.746	0	0	0	0
Kiribati	471697	0.023	99.770	0	0	0	0
Bulgaria	456766	0.023	99.792	2	0	0	0
Gambia	390158	0.019	99.811	0	0	0	0
East Timor	358253	0.018	99.829	0	0	0	0
Indonesia	262353	0.013	99.842	24	0	0	0
Guinea	230149	0.011	99.853	0	0	0	0
Philippines	225651	0.011	99.865	0	0	0	1
Brunei	220512	0.011	99.875	0	0	0	0
Sweden	208935	0.010	99.886	0	0	0	0
Australia	188840	0.009	99.895	3	2	1	0
Angola	171533	0.008	99.903	0	0	0	0
United Arab Emirates	156812	0.008	99.911	0	0	0	20
Kuwait	148136	0.007	99.918	21	0	0	24
Togo	130029	0.006	99.925	0	0	0	0
Afghan	111951	0.006	99.930	22	0	0	0
Ghana	99044	0.005	99.935	6	0	0	3
Syria	87071	0.004	99.940	0	0	0	0
Sierra Leone	84549	0.004	99.944	0	0	0	0

Finland	82000	0.004	99.948	0	0	0	0
Canada	67756	0.003	99.951	1	3	66	8
Greece	66000	0.003	99.954	15	0	0	0
Cameroon	65017	0.003	99.958	1	0	0	0
Sri Lanka	61116	0.003	99.961	0	1	0	0
Netherlands Antilles	60197	0.003	99.964	0	0	0	0
Nepal	59772	0.003	99.967	124	0	0	0
Malta	58900	0.003	99.969	0	0	0	0
Mozambique	54628	0.003	99.972	0	0	0	0
Switzerland	42035	0.002	99.974	10	0	1	0
Cuba	40637	0.002	99.976	0	0	0	0
India	35776	0.002	99.978	102	0	0	0
New Zealand	32964	0.002	99.980	0	0	2	2
Tuvalu	32387	0.002	99.981	0	0	0	0
France	30444	0.002	99.983	42	3	0	0
Norway	30022	0.001	99.984	0	0	0	0
Czech	24000	0.001	99.985	12	2	0	1
Samoa	23281	0.001	99.987	0	0	0	0
Gabon	22161	0.001	99.988	0	0	0	0
Lebanon	19167	0.001	99.989	0	0	0	0
Benin	17007	0.001	99.989	5	0	0	0
Libya	16961	0.001	99.990	0	0	0	0
Korea (Dem.)	16900	0.001	99.991	4	0	0	0
Jordan	16320	0.001	99.992	1	0	0	0
Burkina Faso	15838	0.001	99.993	4	0	0	0
Congo (Dem.)	14953	0.001	99.993	0	0	0	0
Poland	14500	0.001	99.994	24	0	0	0
Turkey	12416	0.001	99.995	220	0	0	2
Tonga	11421	0.001	99.995	0	0	0	0
Mauritania	10059	0.000	99.996	0	0	0	0
Cote d'Ivoire	8185	0.000	99.996	5	0	0	0
Italy	7327	0.000	99.997	20	0	0	0
Congo (Rep.)	6365	0.000	99.997	0	0	0	0
Grenada	6322	0.000	99.997	0	0	0	0
Chile	6044	0.000	99.997	0	0	0	1
Brazil	5712	0.000	99.998	0	0	2	2
Sao Tome and Principe	5403	0.000	99.998	0	0	0	0
Mongolia	5000	0.000	99.998	8	0	0	0
Micronesia	4283	0.000	99.998	0	0	0	0
Seychelles	4169	0.000	99.999	0	0	0	0
Maldives	3958	0.000	99.999	0	0	0	0
Haiti	3360	0.000	99.999	0	6	0	0
Tanzania	3360	0.000	99.999	0	0	0	1
Equatorial Guinea	3340	0.000	99.999	0	0	0	0

Ukraine	2960	0.000	100.000	45	0	0	0
Thailand	1512	0.000	100.000	9	0	23	8
Saudi Arabia	1456	0.000	100.000	30	0	4	39
Iraq	1408	0.000	100.000	6	0	0	0
Ecuador	1174	0.000	100.000	0	0	0	0
Israel	1050	0.000	100.000	17	0	0	7
Suriname	1048	0.000	100.000	0	0	0	0
Myanmar	1000	0.000	100.000	108	0	0	0
Panama	630	0.000	100.000	0	0	0	2
Kenya	186	0.000	100.000	0	0	0	11
Sudan	105	0.000	100.000	18	0	0	0
Costa Rica	100	0.000	100.000	0	0	2	16
Ethiopia	69	0.000	100.000	0	0	0	0
Russian Federation	32	0.000	100.000	151	0	0	0
Nigeria	10	0.000	100.000	65	0	0	0
Total	2027924754			1905	196	127	323

Appendix, Table 6. AI Outbreaks in China

		HPAI			LPAI	
Year	Month	Outbreaks	TAD	TSA	Outbreaks	TSA
2006	April	3	535	0		
2006	May	4	3115	0		
2007	March	1	680	7670		
2007	May	1	11172	20800		
2007	September	1	9830	32630		
2007	December	1	4850	34233		
2008	January	1	1000	14080		
2008	February	2	4125	246062		
2008	March	2	412	2980		
2008	June	1	3873	326177		
2008	December	2	0	376998		
2009	February	1	519	13737		
2009	April	1	1500	3179		
2009	May	2	283	23693		
2010	May	1	170	0		
2011	December	1	290	1865		
2012	March	1	0	35018		
2012	April	2	10473	377450		
2012	June	1	260	797450		
2012	July	1	1600	158039		
2012	September	1	6300	274116		
2013	April				19	20878
2013	May	1	35	407	2	0
2013	December	2	12500	162061	2	2310
Total		34	73522	2908645	23	23188

Note: During the period 2005-2013, there were 34 cases of HPAI and 23 cases of LPAI in China. As a whole, 2,908,645 poultry were infected by HPAI, 23,188 were infected by HPAI, and 73,522 died of HPAI.

Appendix, Table 7. Countries Imposing NTMs While Experiencing HPAI Outbreaks Within Their Borders

Country Imposing NTM	Time of HPAI Outbreaks	NTMs	Countries Affected
Uncooked Poultry			
Egypt	2006.2, 3, 8	SPS	All
Indonesia	2006.8	SPS	All
Japan	2007.1; 2010.11; 2011.1, 3	SPS	All
Japan	2008.4	TBT	All
South Korea	2007.2; 2010.11, 12	SPS	All
South Korea	2008.4,5	TBT	All
Thailand	2008.10	SPS	All
Vietnam	2010.1, 6	SPS	All
Cooked Poultry			
Canada	2007.9	SPS	All
Japan	2008.4	TBT	All
South Africa	2011.8	TBT	All
South Korea	2008.4,5	TBT	All
Thailand	2008.10	SPS	All

Note: All the countries listed above imposed new NTMs while experiencing HPAI outbreaks within their borders. All the measures that these countries implemented were directed against all WTO members.