universitätbonn Institute for Food and Resource Economics
University of Bonn

Discussion Paper 2009:1

Regulatory SPS instruments in meat trade

Simon W. Schlueter
University of Bonn, Institute for Food and Resource Economics, Bonn, Germany
simon.schlueter@ilr.uni-bonn.de

Christine Wieck
University of Bonn, Institute for Food and Resource Economics, Bonn, Germany
christine.wieck@ilr.uni-bonn.de

Thomas Heckelei
University of Bonn, Institute for Food and Resource Economics, Bonn, Germany
thomas.heckelei@ilr.uni-bonn.de

The series "Agricultural and Resource Economics, Discussion Paper" contains preliminary manuscripts which are not (yet) published in professional journals, but have been subjected to an internal review. Comments and criticisms are welcome and should be sent to the author(s) directly. All citations need to be cleared with the corresponding author or the editor.

Editor: Thomas Heckelei
Institute for Food and Resource Economics
University of Bonn
Nußallee 21
53115 Bonn, Germany

Phone: +49-228-732332
Fax: +49-228-734693
E-mail: thomas.heckelei@ilr.uni-bonn.de

Regulatory SPS instruments in meat trade

Simon W. Schlueter, Christine Wieck, Thomas Heckelei

Abstract

Policy makers have to choose between different potentially risk-reducing instruments regulating agri-food trade. Analysing the meat sector, the paper aims at identifying least trade distorting regulations for different policy goals relevant to the SPS agreement. For this purpose, a non-linear gravity model is estimated by Poisson pseudo-maximum likelihood and applied to a panel data set at HS 4-digit level. Regulations are distinguished by a frequency approach allowing to identify the least trade distorting regulation for each policy objective. The results suggest significant differences of trade impacts between types of sanitary regulations.

Keywords: agri-food trade, gravity model, Poisson regression.
JEL-classification: C23, F14, Q17

1 Introduction

Market failure is one important reason for agri-food trade regulations: minimizing trade related risks, they ensure public goods such as food safety, animal health, plant protection, and the protection of humans from pests or diseases. However, given that the implied trade effects of the chosen regulatory instruments are similar to the effects of classical trade policy instruments governing domestic market access, they may also be applied for other than risk reducing effects, i.e. to support domestic producers. Multilateral trade rules as in the Sanitary and Phytosanitary (SPS) agreement on trade in food and agricultural goods offer guidelines to policy makers on how to make use of regulatory instruments. The provisions of the SPS agreement require that regulations targeting specific national policy objectives[1] are minimal with respect to their trade effects (Art. 5.4) and not more trade-restrictive than required (Art. 5.6). Accordingly, Wilson and Anton (2006) define the most welfare efficient SPS measure as least trade distorting but protective in terms of providing the desired health and safety level. However, only lim-

[1] In the SPS agreement, measures regarding the protection of human, animal or plant life, and health are listed as the areas in which World Trade Organization (WTO) member countries can take action in order to achieve their desired level of protection (Art. 2.1).

ited knowledge exists on the specific trade impacts of different regulatory instruments available to enforce desired policy goals. Furthermore, the trade impact of regulatory instruments is not always negative as SPS measures do not simply act as trade barriers to protect domestic producers: safe and healthy food, information transmission, increased producer efficiency, and advanced consumer confidence may also imply positive trade impacts.

Gravity models at various levels of detail have been mostly used to provide evidence on the trade impact of regulatory measures. At the aggregate level of agricultural trade Disdier, Fontagné and Mimouni (2008), de Frahan and Vancauteren (2006), Fontagné, Mimouni and Pasteels (2005), and Moenius (2004) can be mentioned, whereas Wilson and Otsuki (2001), and Otsuki, Wilson and Sewadeh (2001) analyze single standards or sector- or product-specific regulations. Moenius (2004) and Fontagné, Mimouni and Pasteels (2005) find out that a positive trade effect prevails in the manufacturing sector and for processed agricultural products, while for other goods negative ones preponderate. Exports from developing and least developed countries are negatively affected (Disdier, Fontagné and Mimouni 2008, Wilson and Otsuki 2001, Otsuki, Wilson and Sewadeh 2001), whereas trade within countries belonging to the Organization for Economic Co-operation and Development (OECD) is not significantly influenced by regulatory measures (Disdier, Fontagné and Mimouni 2008). Another body of literature applies partial equilibrium models in the quest for an optimal set of SPS measures regarding welfare impacts and risk mitigation strategies. Wilson and Anton (2006) build on the idea of Paarlberg and Lee's (1998) optimal tariff which is accompanied by an additional tariff to mitigate the risk of pest infestation: they suggest an optimal set of SPS measures mitigating the risk of introducing foot-and-mouth disease that is less trade restrictive than bans or tariffs alone. Peterson and Orden (2008) identify an efficient sequence of SPS measures for Mexican avocado imports to the US market. A trade ban is replaced by trade under a risk management system to reduce avocado-specific pest risks. These studies use different methodological approaches but have in common that they do not systematically compare the trade impacts of different regulatory instruments with equivalent risk reduction effects. No information regarding optimal SPS measures is given identifying those that obtain both, desired national policy objectives regarding a specific SPS level and at the same time minimize the negative trade effects.

In analysing the meat sector, the objective of this paper is to test the hypothesis that different regulatory measures imposed to achieve a desired level of SPS health in a country have different implied trade effects. In addition, sanitary regulations are identified which most adequately conform to Art. 5.4 and 5.6 of the SPS Agreement differentiated by classes of regulations and policy objectives. Meat products are chosen because trade in meat is exposed to a wide number of market failures. Diseases, pandemics, meat and feed scandals in the last decade have increased consumers' and producers' awareness of external effects associated with trade in meat products. This motivates policy makers to implement regulatory instruments, which may also serve protectionist purposes.

Using a frequency approach, detailed regulations specific data on sanitary regulations is manually collected and compiled for the years 1996 to 2007 from various international data sources. The information on these regulations is further differentiated by trading partner and year for each meat product line. This result in a very unique data set of regulatory measures that distinguishes all relevant SPS instruments applied for the various purposes in the meat sector. A non-linear panel data gravity model is estimated for the ten most important meat exporters and importers by fixed effects Poisson pseudo-maximum likelihood (PPML) at the level of Harmonized System (HS) 4-digit data.

The remainder of the paper is organized as follows. Section two derives the applied gravity model and introduces the PPML estimator. Section three describes the explanatory and dependent variables and their data sources. Section four presents estimation results on the impact of different risk-reducing regulatory instruments and section five concludes.

2 Theory and methodology

In this application, a non-linear panel data gravity model with fixed effects is estimated by Poisson pseudo-maximum likelihood (cf. Silva and Tenreyro 2006, Olper and Raimondi 2008). Assuming frictionless trade, perfect competition, indifferences of consumers' choices and specialization of countries in different products, the gravity model describes bilateral trade flows by a function of exporter and importer gross domestic product as shown by Deardorff (1998) and Bergstrand (1989):

$$m_{ij} = \frac{Y_i Y_j}{Y^w} \tag{1}$$

where m_{ij} presents trade value from exporting country i to importing country j, Y_i and Y_j are exporter and importer gross domestic product (GDP), and Y^w presents world GDP. The simple gravity equation implies that each country exports its specific product everywhere. Product differentiation can either be obtained by Heckscher-Ohlin trade theory where trade is impeded and factor prices are not equalized as in Deardorff (1998), by Armington-like specifications assuming differentiation by country of origin as in Anderson (1979) and Anderson and van Wincoop (2003), by Ricardian elements as in Eaton and Kortum (2002), or by monopolistic competition and increasing returns as in Helpman (1987), Bergstrand (1989) and Redding and Venables (2004). Dropping the assumption of frictionless trade and integrating different forms of geographic barriers to a somehow formulated trade cost factor possibly also including technical regulations gives the opportunity to assess the impacts of any form of tariff or non-tariff barriers.

One difficulty of estimating gravity type trade models is the existence of heteroscedasticity which may cause inefficient and inconsistent estimates (Silva and Tenreyro 2006). Heteroscedasticity is present when trade flows for small and remote countries may approach zero. This causes the conditional variance of the explained variable for small countries to tend to zero as positive dispersions form the conditional mean cannot be offset by negative ones contrary to large trade flows where the variance can be expected to be larger as the dispersion from the conditional mean can go in either direction. For estimating gravity models the least squares and nonlinear least squares estimators cannot be efficient as they require the conditional variance $\text{var}(m \mid x)$ being constant. Also, in the presence of heteroscedasticity the error term of the log-linearized version of the trade model in equation (1) can only be assumed independent from explanatory variables under very specific conditions on proportionality of the conditional variance. Consequently, all estimators of log-linear models which ignore heteroscedasticity are generally inconsistent (Silva and Tenreyro 2006).

Pseudo-maximum likelihood (PML) estimation is able to handle inefficiencies and inconsistencies caused by heteroscedasticity. Furthermore, zero trade between particular country pairs does not create inconsistencies as in the case when the log-linear form of the gravity equation is used. PML can be understood as a General Methods of Moments estimator with moment conditions corresponding to the first and second order conditions of maximum likelihood. The pseudo-likelihood function is specified appropriately as long as it is based on a probability density function that is a member of the family of linear exponential functions, such as the normal or the Poisson probability density function (Gourieroux, Monfort and Trognon 1984). In employing a PPML estimator in their gravity application, Silva and Tenreyro (2006) start with the conditional expectation of m_{ij} given x, $E\left[m_{ij} \mid x\right]$, which is derived by an utility maximizing model assuming constant elasticity of substitution preferences (cf. Anderson 1979, and Deardorff 1998):

$$E\left[m_{ijt} \mid x_{ijt}\right] = \exp\left(x_{ijt}\beta\right) \tag{2}$$

$m_{ijt} \geq 0$ and $E\left[\varepsilon_{ijt} \mid x\right] = 0$; m_{ijt} and x_{ijt} are vectors of dependent and explanatory variables. This functional form is a good choice in modeling gravity equations, because it produces non-negative conditional expectations (as m_{ijt} is non-negative) without constraining the explanatory variables. When m_{ijt} is assumed to follow a Poisson distribution with expectation $\lambda_{ijt} = \exp\left(x_{ijt}\beta\right)$, a likelihood function $f\left(m_{ijt} \mid x\right)$ can be derived, whose first and second order moment conditions can be solved to obtain the vector of coefficients β (Gourieroux, Monfort and Trognon 1984). The Poisson assumption imposes restrictions on the conditional moments of the explained variable: the conditional variance has to equal the conditional mean $V\left[m_{ijt} \mid x\right] = \mathrm{E}\left[m_{ijt} \mid x\right]$. However, the first and second order conditions of the likelihood function rely only on the correct specification of the conditional mean function (2) regardless of the conditional variance of the explained variable. The PPML estimator is fully robust to distributional misspecifications, i.e. the restrictions imposed by the Poisson assumption do not destroy the consistency property of the estimates when the conditional mean is correctly specified (Wooldridge 1999).

The multiplicative gravity model in this analysis looks as follows:

$$m_{ijt} = p_{it}^{\beta_1} c_{jt}^{\beta_2} d_{ij}^{\beta_3} \exp\left(\alpha_i + \alpha_j + \beta_4 z_t + \beta_5 t_{ijt} + \sum_k \beta_k r_{ijt}^k\right) \varepsilon_{ijt} \quad (3)$$

with $m_{ijt} \geq 0$ and $E\left[\varepsilon_{ijt} \mid x\right] = 0$, where m_{ijt} is the trade value from exporter i to importer j at time t, p_{it} and c_{jt} present the annual meat production and meat consumption quantities of exporter i and importer j and can be interpreted as parameters representing a country's economic size in this sectoral analysis, d_{ij} is the bilateral distance between exporter and importer, α_i and α_j are exporter and importer fixed effects, z_t is the time trend dummy variable, t_{ijt} is the tariff variable.

$$\sum_k r_{ijt}^k \quad (4)$$

presents k different regulatory measures which are included in varying aggregation levels, and ε_{ijt} is the error. Country-specific time-invariant fixed effects α_i and α_j are included to capture unobserved country heterogeneity such as multilateral resistance (Anderson and van Wincoop 2003).[2] Fixed effects models yield similar results to the case when multilateral resistance variables are included directly (Anderson and van Wincoop 2003).

[2] Anderson and van Wincoop (2003) have impressed the idea of multilateral resistance which means the ratio between bilateral trade barriers of two trading countries and the average trade barrier of the two countries with all their trading partners.

Equation (3) can be written as an exponential function

$$m_{ijt} = \exp\left(\beta_1 \ln p_{it} + \beta_2 \ln c_{jt} + \beta_3 \ln d_{ij} + \alpha_i + \alpha_j + \beta_4 z_{ij} + \beta_5 t_{ijt} + \sum_k \beta_k r_{ijt}^k + \ln \varepsilon_{ijt} \right) \quad (5)$$

which equals the functional form of equation (2). The coefficients of the exponential regression function (5) are estimated by PPML.

3 Data

All data is bilateral (exporter-importer related) for each product line and for each year. HS 4-digit data on trade in meat products is coming from United Nations Conference on Trade and Development (UNCTAD) Comtrade for the years 1996 to 2007. Those ten importing[3] and ten exporting[4] countries are included in the analysis which have the highest average aggregated meat trade flow in value terms over the sample period. Zero trade flows between country pairs are included. Consumption of domestic meat is not considered. Altogether there are $n = 11400$[5] observations. 51 % of those observations are positive. Data on sanitary regulations is taken from the WTO SPS Information Management System and the International Portal on Food Safety, Animal and Plant Health (IPFSAPH) which is a joint undertaking between international organizations related to food and trade issues and SPS-recognized standard-setting organizations. This manual search and sampling of information on regulatory measures in the meat sector was necessary given that the conventional data bases for non-tariff measures such as the UNCTAD Trade Analysis and Information System (TRAINS) does not provide the detailed information on applied measures necessary to do a sector-specific analysis that distinguishes the different types of instruments applied. Regulations are arranged into six classes: (1) prevent dispersion of pests and diseases, (2) microbiological testing for zoonoses, (3) maximum residua level, (4) processing of meat, (5) control of production, and (6) treatment and distribution.
Table 1 shows how these classes are divided into specific regulatory instruments. The instruments are assigned to four risk-reducing trade policy goals which are defined as part of the notifications WTO members have to make when implement-

[3] Observed importers: Canada, China, EU15, Hong Kong, Japan, Korea Republic of, Mexico, Russia, Saudi Arabia, USA.

[4] Observed exporters: Argentina, Australia, Brazil, Canada, China, EU15, Hong Kong, New Zealand, Poland, USA.

[5] (95 country pairs) * (12 years) * (10 HS 4-digit codes).

ing regulatory measures: (1) food safety, (2) animal health, (3) plant protection, and (4) protect humans from animal/plant pest or disease.

Table 1. Regulatory instruments and their trade policy goals, 1996-2007

	food safety	animal health	plant protec-tion	protect humans from animal/plant pest or disease	number of counts
prevent dispersion of pests and diseases					4085
pest/disease status	x	x		x	2921
quarantine		x			1110
regionalization		x			54
microbiological testing for zoonoses					4107
e. coli	x			x	1144
listeria monocytogens	x			x	1348
salmonella	x			x	1615
maximum residua level					38969
dioxin	x				1986
food additives	x			x	4482
MRL pesticides	x		x	x	24193
MRL drugs	x	x			5450
MRL other toxins	x				2471
retained water content	x				387
processing of meat					12054
GMO/biotechnology	x	x			3680
hormones	x				1599
other production processes	x				6775
control of production					29837
certification	x	x			3371
inspect., approval procedures	x				9421
HACCP	x				5155
harmonization	x				2113
labelling	x				4247
traceability/registration	x	x		x	1038
risk assessment	x				1963
sanitary requirements for meat establishments	x				2529
treatment and distribution					14709
irradiation	x				3568
meat/bone separation	x			x	126
packaging	x				2365
storage	x				2106
TBT	x				3627
transportation	x				2917
number of counts	102597	17624	24193	36867	

Source: Own compilation

Table 1 also shows the number of counts for each class, each regulatory measure and each trade policy goal. Regulatory measures are counted the first time in the year of entry into force, adoption or notification (depending on data availability) if the date of entry into force, adoption, or notification is in the first half of the year; otherwise, it is assumed that the measures take effect in the following year. All regulatory measures within the class of microbiological testing of zoonoses, maximum residua level, processing of meat, control of production and treatment and distribution are assumed to be effective permanently from the first year of counting. Regulations within the class pests/diseases are assumed to be in force in the first year of counting and the following year allowing for the improvement of the countries' disease status. Meat production and consumption quantities come from the statistical webpage of the Food and Agricultural Organization (FAO).[6] As Hong Kong data are not displayed, they originate from the webpage of indexmundi.[7] Bilateral data on the explanatory variable geographic distance originates from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) homepage.[8] Weighted distance is chosen as distance variable where the EU15 is substituted by Germany. A time trend dummy variable is included. Tariff data stems from UNCTAD TRAINS database. If available, the bilateral effectively applied tariff is chosen; otherwise the most-favourite-nations tariff is incorporated.

4 Results and specification tests

Table 2 presents outcomes of two different models estimated by pseudo Poisson-maximum likelihood. The common base of both models is the exponential regression function (5). The models differ in their insertion of regulatory measures. The model "aggregate" in the first column of table 2 includes one overall aggregate of regulatory instruments being the sum of all counts for a particular country-pair and a tariff line within one year. The model "classes" in the second column of table 2 includes six predefined classes of regulatory measures. The models are tested on the set of conditioning variables and on the functional form. T-tests, Wald-tests and an extension of Ramsey's Regression Equation Specification Error Test (RESET) are carried out by using standard errors which are robust to distributional misspecifications imposed by restrictions of the Poisson assumption (Wooldridge 1999).

---

[6] www.faostat.fao.org.

[7] www.indexmundi.com/agriculture/?country=hk&commodity=beef-and-veal-meat&graph=domestic-consumption.

[8] www.cepii.fr/anglaisgraph/bdd/distances.htm.

Table2. Outcomes of the models “aggregate” and “classes”

	model “aggregate”	model “classes”
production exporter	1.526***	1.736***
consumption importer	1.678***	1.986***
tariff	0.010***	0.009***
geographic distance	-0.931***	-0.964***
aggregate of regulatory measures	0.015***	-
prevent dispersion of pest/disease	-	0.122***
microbiological testing for zoonoses	-	0.087
maximum residua level	-	0.015**
production process	-	-0.091***
control of production	-	0.050**
treatment and distribution	-	-0.128**
R2 (1-SSR/TSS)	0.110	0.122
Wald test H0	rejected***	rejected ***
RESET	not rejected***	not rejected***

Source: Own compilation

The Wald-test rejects the hypothesis that the conditional mean is independent of the explanatory variables for both models. The heteroscedasticity-robust RESET checks the correct specification of the conditional mean expectation by testing the significance of two additional explanatory variables $\left(x\hat{\beta}\right)^2$ and $\left(x\hat{\beta}\right)^3$:

$$m = \exp\left(x\beta + \delta_1 \left(x\beta\right)^2 + \delta_2 \left(x\beta\right)^3\right) \tag{6}$$

(Silva and Tenreyro 2006, Wooldridge 1999). Under the null hypothesis, the additional regressors do not help to explain m_{ijt}, thus δ_1 and δ_2 are zero. The test suggests that the models aggregate, classes, and policy goals are correctly specified, whereas the model regulatory instruments fails passing the test.

The outcomes of the four traditional gravity explanatory variables economic size of exporter and importer, tariff and geographic distance are similar in both models and are all significant at the 1% significance level. The signs of the covariates economic size and geographic distance are as expected: distance negatively affects trade, while the economic size fosters trade flows. The tariff estimate is slightly positive: the coefficient’s estimate of $\exp(0.01) \approx 1.01$ suggests a minor influence of tariffs on today’s meat trade. The first column of table 2 reports additionally the estimate for the aggregate variable. The estimate’s interpretation of $\exp(0.015) \approx 1.015$ affirms the dual impact of regulatory measures on trade: regulations may be trade restricting, trade providing or may have no trade impact at all – a strong tendency cannot be made out from the result of the aggregate variable. The more disaggregated classes' model in column 2 gives first evidence on the differing implied trade effects of regulatory measures. Five of the six estimates are significant. Whereas the classes containing measures regulating the prevention of pests and diseases, the maximum level of residua, and the control of production are trade promoting, the meat processing and the treatment and distribution classes' trade impact is negative.

5 Conclusion

Using a non-linear panel data gravity model, this paper analyses the trade effects of different regulatory measures that are imposed in the meat sector in order to achieve a desired level of SPS health in a country. We use a new and unique data set given that the applied national regulatory instruments are sampled from information provided by WTO and SPS-standard setting international organizations and are grouped according to the SPS areas they apply to and according to the political objectives they serve. The disaggregated analysis of the trade effects of regulatory instruments reveals the theoretically well-known ambiguous trade impact of many of these measures: at the class level we find that pest/disease prevention, microbiological testing for zoonoses, setting of residual levels, and control of production lead to positive impacts on trade flows whereas processing restrictions and treatment and distribution requirements have the opposite effects. These results contrast with the findings of recent research by Disdier, Fontagné and Mimouni (2008) who estimate a strong negative impact of SPS and TBT measures on meat trade using a log-linear fixed effects gravity model with HS-2 digit data. Apart from the differences in the level of detail and disaggregation of the two studies, further reasons in the differences of the findings may lie in the fact that Disdier, Fontagné and Mimouni (2008) do not handle the methodological challenges resulted to heteroscedasticity and that they base their estimation on a less sophisticated data set of SPS measures.

Limitations that apply to this paper result from the fact that a frequency count is used to characterize the importance of the measures. This does not allow comparing the food safety level achieved by a specific measure to the trade restriction that it imposes. A comparison of the measures in the sense of the SPS agreement, i.e. in terms of how they achieve a specific national safety level while minimizing the trade impact, is not possible with a frequency count. For this, more theoretical work on how to compare and quantify the potential food safety levels (or food safety risk reductions) that are achievable with single measures or sets of measures is necessary.

To conclude, the sampling of a detailed data set on regulatory measures in an important food sector contributes to the knowledge base of trade impacts of SPS measures and may provide the ground to further analyze the potential food safety improvements possible relative to the trade impacts implied by specific measures.

References

ANDERSON, J.E., 1979. A Theoretical Foundation of the Gravity Equation. The American Economic Review 69(1), 106-116.

ANDERSON, J.E., VAN WINCOOP, E., 2003. Gravity with Gravitas: A Solution to the Border Puzzle. The American Economic Review 93(1), 170-192.

BERGSTRAND, J.H., 1989. The Generalized Gravity Equation, Monopolistic Competition, and the Factor Proportions Theory in International Trade. Review of Economics and Statistics 71(1), 143-153.

DEARDORFF, A.V. 1998. Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World? Frankel, J.A. (Ed.), The Regionalization of the World Economy. University of Chicago Press, 7-32.

DE FRAHAN, B.H., VANCAUTEREN, M.,. 2006. Harmonisation of Food Regulations and Trade in the Single Market: Evidence form Disaggegated Data. European Review of Agricultural Economics 33(3), 337-360.

DISDIER, A.-C., FONTAGNÉ, L., MIMOUNI, M.,. 2008. The Impact of Regulations on Agricultural Trade: Evidence from the SPS and TBT Agreements. American Journal of Agricultural Economics 90(2), 336-350.

EATON, J., KORTUM, S., 2002. Technology, Geography, and Trade. Econometrica 70(5), 1741-1779.

FONTAGNÉ, L., MIMOUNI, M., PASTEELS, J.-M., 2005. Estimating the Impact of Environmental SPS and TBT on International Trade. Integration and Trade Journal 22, 7-37.

GOURIEROUX, C., MONFORT, A., TROGNON, A., 1984. Pseudo Maximum Likelihood Methods: Applications to Poisson Models. Econometrica 52(3), 701-720.

HELPMAN, E., 1987. Imperfect Competition and International Trade: Evidence form Fourteen Industrial Countries. Journal of the Japanese and International Economies 1(1), 62-81.

MOENIUS, J., 2004. Information versus Product Adaptation: The Role of Standards in Trade. Working paper, Northwestern University, Evanston.

OLPER, A., RAIMONDI, V., 2008. Agricultural Market Integration in the OECD: A Gravity-Border Effect Approach. Food Policy 33, 165-175.

OTSUKI, T., WILSON, J.S., SEWADEH, M., 2001. Saving Two in a Billion: Quantifying the Trade Effect of European Food Safety Standards on African Exports. Food Policy 26, 495-514.

PAARLBERG, P.L., LEE, J.G., 1998. Import Restrictions in the Presence of a Health Risk: An Illustration Using FMD. American Journal of Agricultural Economics 80(1), 175-183.

PETERSON, E.B., ORDEN, D., 2008. Avocado Pests and Avocado Trade. American Journal of Agricultural Economics 90(2), 321-335.

REDDING, S., VENABLES, A.J., 2004. Economic Geography and International Inequality. Journal of International Economics 62, 53-82.

SILVA, J.M.C.S., TENREYRO, S., 2006. The Log of Gravity. The Review of Economics and Statistics 88(4), 641-658.

WILSON, N.L., ANTÓN, J., 2006. Combining Risk Assessment and Economics in Managing a Sanitary-Phytosanitary Risk. American Journal of Agricultural Economics 88(1), 194-202.

WILSON, J.S., OTSUKI, T., 2001. Global Trade and Food Safety. Working paper 2689, Development Research Group, The World Bank, Washington DC.

WOOLDRIDGE, J.M. 1999. Quasi-Likelihood Methods for Count Data. Pesaran, M.H., Schmidt, P., (Eds.) Handbook of Applied Econometrics. Blackwell Publishers Ltd., 352-406.