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Food Safety Standards and Export Competitiveness in the Processed Food Industries of Asia-Pacific Countries

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Developing country producers face several constraints related to food safety standards imposed by developed countries. The purpose of this study is to identify factors affecting export flows with respect to food safety standards; and to measure the effects of food safety standards on exports.

This study incorporates a food safety variable in a gravity model. The analysis uses aggregate data for bilateral exports of processed food products, and data for factors affecting bilateral export flows for 17 years on 16 OECD and Asia-Pacific countries.

The results show that food product exports are negatively affected by aflatoxin standards. A one percent increase in food safety standards decrease exports by approximately one percent. This means that large changes in food standards (which are common these days) will have salutary, deleterious impacts on food exports by developing countries.

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International trade in food and processed food products has expanded enormously over the last ten years. World exports of processed food increased at the rate of 8.5% per year during 1970-2003, and the share of processed products in agricultural exports increased from 42% in 1990-91 to 48% in 2001-02 (AP, 2006, cited in Mohanty). The reason behind this upward trend outflow in processed products is developed countries' changing food consumption patterns and the growing demand for "ready to eat" food.

While the growth in demand for ready to eat food creates exciting opportunities for food processing industries, developed countries' environmental and health related requirements act as important non-tariff barriers to exports. Developing country producers face several constraints related to increasingly more stringent food safety standards imposed by developed countries. The U.S., the E.U., and Japan have strict requirements on food and processed food products. Differing standards across markets are another constraint. For example, chlorine is used in many countries to destroy pathogenic bacteria in food but in other countries it is completely forbidden in food contact applications.

The food safety concerns by developed countries are not without merit. A wide range of chemical substances including pesticides and additives are commonly used in food production and processing, and residues of these chemicals may remain in the end products. These residues can be harmful for humans, animals and plants, and the environment in which they live. So, consumers in developed countries have exhibited a high level of food safety concern related to their processed food supply, though their growing demand for "ready to eat" food has increased. Developed countries have increasingly called for assurances that food is free from substances such as pesticides, chemical additives, hormones, and antibiotics. However, the economic nature of the food safety issue in developing countries is somewhat different from developed countries. Their concern is about food safety regulations enforced by developed countries that act as important non-tariff barriers: these standards increase compliance costs of suppliers and thus reduce their export competitiveness.

Despite the concern of the term "Food safety" in both national and global forums, little attention has been paid to examining its empirical relationship with international competitiveness. This study aims at reviewing challenges Asia-Pacific food exporters are facing in exporting to developed countries, because of food safety standards. The purpose of this study is twofold: first is to identify factors affecting export flows with respect to food safety standards; and second is to measure the effects of food safety standards on exports from the selected countries.

Review of literature:

There are a considerable number of studies regarding food safety and international trade that range from theoretical and policy analyses to empirical analyses. However, empirical analyses of the impact of standards and technical regulations on trade, in particular food safety standards, on export flows in the food and food manufacturing in Asia-Pacific countries are relatively sparse. The literature includes two types of studies. Ones that perform case studies or surveys for policy analysis on food safety standards and the challenges exporting firms face due to increasingly more stringent food safety standards. Another group employs econometric models to determine how domestic policies impact bilateral trade flows. The econometric approach which is most often used in the literature is the gravity model. Some investigators construct policy indices (food safety standards) by survey and use these indices as proxy for the severity of standards in the gravity model. Other investigators use direct measures of food safety standards.

The gravity model:

The gravity model, Tinbergen (1962) and Linneman (1966), is commonly used to determine whether a domestic policy positively or negatively influences the competitiveness of international trade. A number of authors set up domestic standards and technical regulations as proxies for their impact (environmental stringency) or severity (food safety standards) in the gravity model. Among the noteworthy works are Harris et al. for environmental policy impacts, and Jayasuriya et al., Wilson and Otsuki, Otsuki et al., and Lacovone for food safety regulations.

Harris et al. investigated the relationship between environmental regulations and international competitiveness using the following form of the gravity equation:

$$\begin{aligned}\ln IMP_{ijt} = {} & \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 \ln POP_{jt} \\ & + \beta_5 \ln DIST_{ij} + \beta_6 ADJ_{ij} + \beta_7 \ln EEC_{ijt} + \beta_8 \ln EFTA_{ijt} + \beta_9 \ln NAFTA_{ijt} \\ & + \beta_{10} \ln LAND_i + \beta_{11} \ln LAND_j + \beta_{12} \ln SC_{it} + \beta_{13} \ln SC_{it} + u_{ijt}\end{aligned}$$

where, *ln* represents natural logarithm; IPM_{ijt} is the imports of country *i* from country *j* in year *t*; GDP_{it}, GDP_{jt}, the GDPs of country *i* and *j*, respectively, in year *t*; POP_{it}, POP_{jt}, the population of country *i* and *j*, respectively, in year *t*; $DIST_{ij}$, the distance between country *i* and *j*; ADJ_{ij}, , EEC_{ijt}, , $EFTA_{ijt}$, and $NAFTA_{ijt}$, are dummy variables identifying adjacency and trade agreements; $LAND_i$, $LAND_j$, the land areas of country *i* and *j*, respectively; SC_{it}, SC_{jt}, scores measuring the relative strictness of environmental regulations in country *i* and *j*, respectively, in year *t*; and U_{ijt} denotes the error term. They examined the effect of environmental stringency by six different indicators based on energy consumption or energy supply. However, the consistently found that the effects of these environmental indicators was not statistically significant.

Jayasuriya et al. investigated the impact of increasingly stringent and differing standards set by developed countries on exports by India's food processing industries. In their research they constructed an index to measure food safety standards through a survey of processed food industries. They used the gravity model and the index of food safety standards was used as proxy of its severity. Their index was a weighted value of different groups of standards (microbial hazards, pesticides, antibiotics, toxic chemicals etc) in the importing countries relative to the *Codex* standard. Among the exporting countries, they found that food exported to EU countries, Australia and the US faced extremely restrictive standards, while exports of food to Canada and Japan faced moderately restrictive standards. They estimated that compliance costs averaged 5% of sales revenue, though they range from 10-15% for some food products. Based on their empirical results, they concluded that stringent food safety standards limit Indian processed food exports.

Using such an aggregated index for technical standards to determine impacts on trade flows is subject to serious limitation. The aggregated index constructed from different standards provides results inconsistent with conceptual expectation. For example, Swann (1996) and Moenius (1999) worked with two different standards such as shared standards (standards were used separately), and unilateral standards (a number of heterogeneous standards were aggregated, and used as indices). Swann's findings suggested that share standards positively impact exports, but had a little impact on imports; unilateral standards positively influence imports but negatively influence exports. However, Moenius found that the shared standard has a positive impact on trade, and the unilateral standard enhances manufacturing trade, but limits trade in non-manufacturing sectors (Lacovone).

Lacovone's investigation suggests a way to overcome these shortcomings. He used maximum tolerated levels of aflatoxin B1, a commonly used determinant in food and food products, as a direct measure of the severity of the Aflatoxin standard. He developed an extended gravity model to explain Latin American nut exports to Europe and found that there were substantial export losses to Latin-America from the tightening of the aflatoxin standards set by Europe.

Two other studies are supportive of using this direct measurement method. Wilson and Otsuki used a gravity model in their investigation on import flows of cereals and nuts. They concluded that these imports are negatively affected by the aflatoxin standard. Otsuki et al. also utilized a gravity model with the maximum aflatoxin level allowed measuring food safety standards in their analysis of African food product exports to EU counties. They concluded that tightening the aflatoxin level by EU countries reduces African food exports to the EU by 64 percent or US$ 670 million. They also found that the health risk in EU countries was reduced by approximately 1.4 deaths per billion a year due to these stiffer food safety standards.

Model specification:

This study follows a gravity model approach which derived from the demand and supply functions of importing and exporting countries at the general market equilibrium conditions as reflected in Anderson and Wincoop. The model assumes a CES (Constant Elasticity of Substitution) utility function for consumers in the importing country that is constrained by income. It is assumed that each country produces only one good and the supply of the good is fixed.

The consumers' demand equation of the importing country for goods of an exporting country is derived by maximizing the consumers' utility function subject to the income constraint. The market clearing condition (aggregate import demand equals aggregate supply) is used to derive the profit function for the exporting country. Trade barriers and trade (transportation) costs C_{ij} are assumed to be a log linear function of observables, bilateral distances (*D*), and adjacency or border (*B*) between importing and exporting countries.

These assumptions give the following gravity equation:

$$X_{ij} = \frac{I_i I_j}{\sum_j I_j} \left(\frac{D_{ij} B_{ij}}{P_i P_j} \right)^{\frac{1}{\rho}} \qquad (1)$$

where X_{ij} is exports from country i to j; I_i and I_j is total income of country i and j, respectively; D_{ij} is the distance from country i to j; B_{ij} is whether there is a shared border between I and j; P_i is the price in the exporting country and P_j is the price in the importing country; ρ is the elasticity of substitution between all goods

Taking logs and appending error terms, we can write the following empirical form of the gravity model:

$$\ln X_{ij} = k + \ln I_i + \ln I_j + \tfrac{1}{\rho}\ln D_{ij} + \tfrac{1}{\rho}\ln B_{ij} - \tfrac{1}{\rho}\ln P_i - \tfrac{1}{\rho}\ln P_j + \mu_{ij} \qquad (2)$$

In this empirical analysis, we incorporate a food safety standard variable with the expectation that this standard reduces a country's export competitiveness. The two price terms in the above equation (so called multilateral resistance variables) are not observable and difficult to measure so we did not use the terms but instead incorporate export and import price indices as Bergstrand did. Including all these factors that explain bilateral exports, the extended gravity equation for this study has the following form:

$$\begin{aligned}\ln EX_{ijt} = \beta_0 + \beta_1 \ln GDP_{ti} + \beta_2 \ln GDP_{jt} + \beta_3 \ln Dis_{ij} \\ + \beta_4 \ln EPI_{it} + \beta_5 \ln IPI_{jt} + \beta_6 \ln FSS_i + \varepsilon_{ijt}\end{aligned} \qquad (3)$$

where, GDP_{ti} is per capita *GDP* of country *i* at time *t*; GDP_{jt} is per capita *GDP* of country *j* at time *t*; EPI_{it} is export price index of country *i* at time *t*; IPI_{jt} is import price index of country *j* at time *t*; Dis_{ij} is distance between country *i* and *j*; FSS_i is the food safety standards in terms of aflatoxin with maximum allowable level imposed on imports by country *i*; and ε_{ijt} is an error term assumed to be normally distributed.

Equation (3) is the classical double-log specification, and the explanatory variables used in this model have a direct relationship to bilateral export flows. In this model, GDP_i measures the potential demand of the importing country, while GDP_j represents the potential supply of the exporting country. Therefore, the corresponding slope parameters, β_1 and β_2, are expected to be positive. The rational for geographical distance is that a higher distance between trading partners leads to higher transportation costs and increased differences in preferences. Dis_{ij} is a proxy for resistance to trade, thus it is anticipated that β_3 will be negative. The slope parameter β_4 is probably negative because exporter's high prices reduce outward trade flows. On the other hand, it is anticipated that β_5 will be positive because importer's increased prices may cause production in home country to fall and inward trade flows to rise (Bergstrand). Finally, FSS_i measures how strict the food safety standards are in importing countries. In line with the assumption that strict standards lead to relatively lower exports. In this model, the strictness of the standards depends on the tolerable level of aflatoxin B1: a lower level of aflatoxin standard indicates a more restrictive standard. Therefore, we anticipate that β_6 will be positive, which implies stiffer standard impact exports negatively.

Data sources and descriptions:

This study focuses on the factors affecting bilateral trade with special attention on the impact of food safety standards for different importing countries. The gravity model used in this study requires the following data for each country: exports of food and food products as dependent variables, country's total GDP, per capital GDP, population, geographical distance, export price index, import price index, membership in European Union (EU) and food safety regulations in terms of aflatoxin standards as explanatory variables. The data utilized in this model are collected for seventeen years, 1988-2005, on 16 countries that include OECD and Asia-Pacific countries (Australia, Austria, Canada, China, Fiji, France, Germany, India, Indonesia, Italy, Japan, Nepal, Sri Lanka, United Kingdom, the United States and Vietnam). The sources and description of data are:

Data for bilateral trade, in particular, the value of exports and imports of food and food products in US dollar under the classification of SITC Rev.3, are collected from United Nations Statistics division available online at http://unstats.un.org/unsd/comtrade/

Each country's Gross Domestic Product (GDP) and per capita GDP (both in constant 2000 US dollars) are collected from World Bank Development Indicator (WDI) available online at http://devdata.worldbank.org/dataonline/. Each country's population is collected from Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2004 Revision and World Urbanization Prospects: The 2003 Revision, http://esa.un.org/unpp

Data for geographical distances are collected on the basis of the average distance between the major sea ports of the two countries. Since there are no waterways in Nepal, and the only practical seaport for goods bound for Katmandu, the capital city of Nepal, is Calcutta in India, we used the distance to Calcutta (including road distance in miles from Calcutta to Katmandu) for the country, Nepal. The data for distance are measured in nautical miles, and collected online at http://www.distances.com/

The export price index of the exporting countries and the import price index of the importing countries are collected from World Bank Development Indicator (WDI) available online at http://devdata.worldbank.org/dataonline/

To measure the effect of food safety standards on trade flows we use aflatoxin standards as an explanatory variable. The data for aflatoxin standards are obtained from the FAO publication, Worldwide Regulations for Mycotoxins 1995: A Compendium. The data for maximum allowable levels of aflatoxins in parts per billion (*ppb*) are stated below:

Table 1: Maximum tolerated levels of aflatoxins in food and food products

Country	Maximum tolerated levels of aflatoxins (*ppb*)		Country	Maximum tolerated levels of aflatoxins (*ppb*)	
Australia	5	For all foods	India	30	For all foods
Austria	1	For all foods	Italy	5	For all foods
Canada	15	For nuts	Japan	10	For all foods
France	10		UK	4	For nuts and figs
Germany	2	For all foods	USA	20	For all foods

Source: Food and Agriculture Organization of the United Nations, 1997

Aflatoxins are present in foods as natural contaminants and cannot be completely excluded from the food chain. The most potentially toxic aflatoxin is designated as aflatoxin B1, and causes acute toxicity in animals and humans (Otsuki et al.), so it needs to be as low as possible. In this context, the maximum allowable level of aflatoxin B1 imposed for food and food products is considered to determine the level of food safety standard in a country: the greater values of aflatoxin B1 in foods implies a more lax standard.

Empirical results:

We use aggregate data for bilateral exports of food and processed food products, and data for factors affecting bilateral export flows for 17 years on 16 OECD and Asia-Pacific countries. The major question that surfaces from imposing food safety regulations in importing countries is whether and what extent are exports in the food and processed food industry influenced by the food safety regulations? To address this question, we estimate a linear version of the empirical model given in equation (3), and the results are reported in Table 2.

Estimated results show that the F value is statistically significant at the 1% level. The R^2 values indicate that the overall goodness of fit of the regression is satisfactory. Table 2 shows the regression analyses (Equation (3)) for food and food products exports as influenced by aflatoxin B1 (*FSS*) with other factor variables, exporter's per capita GDP (*GDPX*), importer's per capita GDP (*GDPM*), geographical distances (*DIST*), exporter price index (*EPIX*) and importer's import price index (*IPIM*). In this regression, the parameter estimate on the policy variable (Aflatoxin B1) is positive and statistically significant at the 1% level. Since a greater value of aflatoxin B1 implies relaxation of aflatoxin contamination, the positive sign of the coefficient implies that the bilateral trade increases with relaxation of the standard. Because a double-log specification is used in the model, the coefficient is the elasticity, suggesting that a 1% tightening of the standard reduces bilateral exports by 0.98%. Jayasuriya et al. also found that Indian food exporters received significant losses from stringent food safety regulations. This result is also consistent with the findings of Lacovone, and Otsuki et al.

The coefficients both for the exporter's per capita *GDP* and importer's per capita *GDP* are significantly positive at the 1% level (as expected). The results suggest that a 1 per cent increase in the per capita *GDP* in the exporting country is associated with 2.9% increase in bilateral exports, whereas a 1 per cent increase in the per capita *GDP* in the importing country is associated with 0.55% increase in exports. These results are expected and supported conceptually. The coefficients of other variables, distances (*DIST*), exporter price index (*EPIX*) and importer's import price index (*IPIM*) are not statistically different from zero.

The effects of food safety regulations seem rather small, except that they can change drastically for a country. Moving the aflatoxin tolerance from 20 (the US's standard) to 4 (the UK's standard) is a 500% increase in the standard. Thus, if the US adopted the UK's food safety standards, exports by these countries would be only 20% of what they were before – a tremendous decrease. This would seriously impair developing country food exporters.

Table 2: Regression results of bilateral exports in the food and food product sector

Variable	Parameter estimates	Standard Error	t Value	Pr > |t|
Intercept	-7.31 [a]	2.58	-2.83	0.0048
Exporter' s per capita GDP (GDPX)	2.93 [a]	0.23	12.85	<.0001
Importer' s per capita GDP (GDPM)	0.55 [a]	0.08	6.75	<.0001
Distances (DIST)	0.34	0.40	0.86	0.3908
Exporter's export price index (EPIX)	-0.68	0.58	-1.17	0.2407
Importer's import price index (IPIM)	-0.02	0.15	-0.10	0.9202
Food Safety Standard (FSS)	0.98 [a]	0.11	8.80	<.0001
F value 54.4	R^2 0.39		Adjusted	R^2 0.39

Notes: [a] and [b] indicate significant at 1% and 5% level, respectively. All the variables are in logs.

Conclusion:

In this study, we estimate regressions based on an extended gravity model to determine the possible influence of food safety standards on export flows of six Asia-Pacific countries to ten importing countries. We studied the constraints and challenges exporters in Asia and the Pacific face in exporting food and food products in world markets. Six countries (China, Fiji, Indonesia, Nepal, Sri Lanka and Vietnam) are facing problems in meeting increasingly more stringent food safety requirements imposed by developed countries such as Japan, EU and the U.S. The major question that surfaces from imposing food safety regulations in importing countries is whether and what extent are exports in the food and processed food industry influenced by the food safety regulations? To address this question, we examine the relationship between bilateral exports and importers' imposition of food safety standards along with other control variables affecting bilateral exports. We obtain empirical evidence on the adverse effect of food safety standards on export performance in food and food manufacturing.

The empirical results show that the value of exports in food and food products is negatively affected by aflatoxin standards: the greater the food safety standards, the lower its restrictiveness, and higher the bilateral export flows. A one percent increase in food safety standards decrease exports by approximately one percent. This means that large changes in food standards (which are common these days) will have salutary, deleterious impacts on food exports by developing countries.

The result also shows that economic activities in the exporting and importing countries (specifically their GDPs) have significant impacts on food exports. These variables are moving upward each year so these factors will have a positive affect on developing country food exports in the future. The results indicate that prices and distance do not have significant impacts on food exports of developing countries. If distribution systems are established between developing and developed countries, changes in prices do not seem to deter international trade.

Despite all of the contraints and challenges Asia-Pacific exporters face in meeting food safety regulations, exports of food and processed food products have grown for the region. We have found empirical evidence on the inverse impact of food safety regulations on trade performance in the food and processed food sector. In our study, we had limitation on availability of uniform cross-sectional data so some important countries that could enrich database, were omitted. This study gives an insight into food safety standards, but given the lack of robustness of research results in this area, and increasingly importance for food safety policy-making over international trade in both developing and developed countries, further empirical research is necessary. The research could focus on a simultaneous research project that includes consumers' concern about the safety of food supply in developed countries and the impact of food safety regulations on specific food exports from the developing country.

References:

Anderson, J. E. 1979. "A Theoretical Foundation of Gravity Equation" American Econ. Review. 69(1): 106-16.

Anderson, J. E. and E. V. Wincoop. 2003. "Gravity with Gravitas: A Solution to Border Puzzle" American Econ. Review. 93(1): 170-192.

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

Food and Agriculture Organization. 1997. Worldwide Regulations for Mycotoxins 1995: A Compendium. Food and Nutrition Paper, 64. FAO, Rome.

Jayasuriya, S., D. MacLaren, and R. Metha. "Meeting Food Safety Standards in Export Markets: Issues and Challenges facing Firms Exporting from Developing Countries". Paper presented at the IATRC Summer Symposium, Food Regulation and Trade: Institutional Framework, Concepts of Analysis and Empirical Evidence, Bonn, Germany, 28-30 May 2006.

Lacovone, L. 2003. “Analysis and Impact of Sanitary and Phytosanitary Measures”. Available online at http://www.cid.harvard.edu/cidtrade/Papers/iacovone.pdf

Linneman, H. 1966. An Econometric Study of international Trade Flows. North-Holland Publishing Co.

Moenius, J. 1999. "Information versus Product Adaptation: The Role of Standards in Trade." Northwestern University, Kellogg Graduate School of Management.

Mohanty, S. K. 2006. “Trade and Environment Dimensions in the Food and Food Processing Industries in Asia and the Pacific: Regional Study”. Link from the Environmental and Sustainable Development, United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) Homepage: http://www.unescap.org/esd/environment/cap/meeting/regional/index.asp.

Otsuki, T., J. Wilson and M. Sewadeh (2001) Saving Two in a Billion: Quantifying the Trade Effect of European Food Safety Standards on African Exports, *Food Policy* 26: 495-514.

Swann. 1996. "European Economic Integration: the Common Market, European Union and Beyond" Cheltenham, UK Brookfield, US, Edward Elgar.

Tinbergen, J. 1962. Sharing the World Economy: Suggestions for an International Economic Policy. New York: The Twentieth Century Fund.

Wilson J., and T. Otsuki. 2001. “Global Trade and Food Safety: Winners and Losers in a Fragmented System”, Research Paper, World Bank. Available online at http://www.sice.oas.org/geograph/standards/otsukiw.pdf