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A Race to the Top?

A Case Study of Food Safety Standards and African Exports

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Implementation of the European Union's new aflatoxin standards will reduce African exports to Europe of nuts, cereals, and dried fruits, products highly sensitive to the aflatoxin standards. The EU standards would reduce health risks by only about 1.4 deaths *per billion* a year but would cut African exports by 64 percent, or $670 million, compared with their level under international standards.

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Summary findings

Growing concern over health risks associated with food products is at the forefront of trade policy debate. At the heart of this debate is the "precautionary principle," which holds that precautions should be taken against health, safety, and environmental risks even when science has not established direct cause-and-effect relationships—as with, for example, the European ban on hormone-treated beef.

Otsuki, Wilson, and Sewadeh quantify the impact on food exports from African countries of new EU standards for aflatoxins, structurally related toxic compounds that contaminate certain foods and lead to the production of acute liver carcinogens in the human body.

The authors estimate the impact of changes in differing levels of such protection based on the EU standards (and suggested by international standards) for 15 European countries and 9 African countries between 1989 and 1998.

The results suggest that implementation of the EU's new aflatoxin standards will significantly hurt African exports to Europe of nuts, cereals, and dried fruits, which are highly sensitive to the aflatoxin standards.

The EU standards would reduce health risks by only about 1.4 deaths per billion a year but would cut African exports by 64 percent, or $670 million, compared with their level under international standards.

This paper—a product of Trade, Development Research Group—is part of a larger effort in the group to study the trade impact of regulation and standards from a development perspective. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Lili Tabada, room MC3-333, telephone 202-473-6896, fax 202-522-1159, email address ltabada@worldbank.org. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. Tsunehiro Otsuki may be contacted at totsuki@worldbank.org. March 2001. (32 pages)

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A Race to the Top?

A Case Study of Food Safety Standards and African Exports

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I. Introduction

While traditional trade barriers in agriculture such as tariffs continue to decline, technical and regulatory barriers are increasingly subject to debate. This includes discussion over the appropriate levels of sanitary and phytosanitary standards (Wilson, 2000). Public discourse and concern about the health risks of food and appropriate sanitary standards have been emerging in industrialized countries (Pinstrup-Andersen, 2000), and they have been especially prominent in Europe (Nielsen and Anderson, 2000). The use of import bans and regulatory intervention by the European Commission is increasingly justified, in part, under the precautionary principle which seeks to mitigate against risk even under conditions in which science has not established direct cause and effect relationships. The Commission's approach has been challenged, therefore, in trade policy talks on the basis that import restrictions have been employed without sufficient support in international science. The ban in Europe of hormone-treated beef is one recent and high profile example.

The cost of regulatory intervention by any nation with the intent to protect human health can be significant. This is especially true for developing countries attempting to penetrate developed country markets. In low and middle- income countries, the share of food exports in total trade remained high at approximately 13 percent in the 1990's (See Fig. 1). If increasingly restrictive sanitary and phytosanitary measures limit market access, these countries may incur significant export losses. Many questions remain, however, including how to approach the trade-off between appropriate levels of risk to human health and costs of differing levels of protection set in standards to international trade. In addition, we know little about the specific impact of harmonized standards shared across national boundaries, in contrast to divergent national standards.

Measuring the trade effect of sanitary and phytosanitary standards is particularly complex, as well documented in Orden and Roberts (1997). Notwithstanding these complexities it is clear the costs of regulatory intervention can be high relative to non-intervention. Food exports subject to regulatory standards may involve rejection of imports following border inspection. Between June 1996 and June 1997 the U.S. rejection level of food additives imports from developing countries averaged 3 percent of total food imports.[1] The loss arising from rejection is not limited to the value of the product. It also includes transportation and other export costs, all of which are incurred by the exporter. Compliance requirements on exporters impose non-trivial costs especially on developing countries, such as the cost of upgrading production systems, processing and storage equipment, and quality control stations (Henson et al., 2000).

How regulatory costs for exporters compare with possible gains in higher sanitary and phytosanitary levels in importing countries is a key part of trade policy debate. Information on how standards affect trade flows when an international standard is in place and shared bilaterally, as opposed to conditions in which differing national standards are imposed on exporters is increasingly valuable. As recently reviewed in Maskus and Wilson (in press) the empirical evidence and information on the trade impact of standards is extremely limited. The importance of providing estimates of how standards impact trade flows is clear.

In this paper we examine a European Commission proposal to harmonize aflatoxin standards announced in 1998 and scheduled for enforcement in 2000. This proposal raised a number of disputes between the Commission and trade partners in the World Trade Organization (WTO). The case serves as a good example of the trade-off between acceptable levels of risk, how harmonized standards affect trade, and contrasting perspectives of developed and developing countries in international trade disputes. This paper provides empirical evidence to inform discussions of these issues through a case study of aflatoxins standards and trade in food between Africa and Europe.

Based on the Food and Agriculture Organization's cross country survey on food safety standards, we develop an econometric method to statistically measure the trade flow effect of standards imposed through domestic regulation. The results are then used to calculate potential export revenue gains and losses with changing standards. We examine trade in cereals, fruits, nuts and vegetables between 15 member states of the European Union and 9 Africa countries in the ten years prior to 1998. Instead of identifying cost elements to comply with the standards, this paper examines changes in trade flows, as they are a direct consequence of differing approaches to regulation which intersect debate on how best to address these issues within the rules based system of the WTO.

II. Regulations on aflatoxin contamination and international standards

Aflatoxins are a group of structurally related toxic compounds which contaminate certain foods and result in the production of acute liver carcinogens in the human body. They were discovered in 1960 following the deaths of 100,000 turkeys in the United Kingdom and high incidences of liver disease in ducklings in Kenya and hatchery trout in the United States (U.S. Food and Drug Administration, 2000).

The major aflatoxins of concern are designated B1, B2, G1, and G2, and these toxins are usually found together in foods (UNDP[2]-FAO[3], 2000). Aflatoxin B1 is usually predominant and the most toxic of the four categories and has been identified in corn and corn products, groundnuts and groundnuts products, cottonseed, milk, and tree nuts such as Brazil nuts, pecans, pistachio nuts, and walnuts (FAO-WHO[4], 1997).

Aflatoxins have acute and chronic toxicity in animals, however, their toxicity in humans has been encountered only rarely. One of the most important cases of aflatoxin contamination occurred in 150 villages in Northwest India in the fall of 1974. According to one report of this outbreak, 397 persons were affected and 108 persons died. Contaminated corn was the major cause. A second outbreak was reported in Kenya in 1982 where aflatoxin intake was estimated at 38 μg/kg body weight for an undetermined number of days. In developed countries, aflatoxin contamination rarely occurs at levels that cause acute carcinogens in humans, therefore studies on human toxicity from ingestion of aflatoxins have focused on their carcinogenic potentials.

A number of studies have revealed an association between liver cancer incidence and the aflatoxin content of the diet. These studies have not established a cause and effect relationship but rather suggest an association. A 1997 report by the joint FAO/WHO Expert Committee on Food Additives (JECFA) concluded that "aflatoxins should be treated as carcinogenic food contaminants, the intake of which should be reduced to levels as low as reasonably achievable" (FAO-WHO, 1997). JECFA analyzed potential human health impact of aflatoxin for two hypothetical levels (10 part per billion (ppb) and 20 ppb). It estimated that reducing the standard from 20 ppb to 10 ppb in countries where percentage of carriers of hepatitis B1 is around one percent (e.g. members of the European community) would result in a drop in the population risk of approximately 2 cancer deaths a year per billion people.[5]

The European Commission's regulation of aflatoxins

Until 1998 members of the European Union implemented different standards for aflatoxins in foodstuffs. As Table 1 indicates, the stringency of the standards varied across countries. Austria, for example, set the standard for aflatoxin B1 at one ppb, while Portugal had its standard at 20 ppb. Some countries set tighter standards on particular product category. For example, France had a very stringent aflatoxin B1 standard on groundnuts but a much more lax standard on other foods. In general, a tighter standard was applied to foodstuffs intended for direct human consumption than those subject to further processing.

In 1997 the European Commission proposed a uniform standards for total aflatoxins setting the acceptable level of the contaminant in certain foodstuffs. For example, it set a standard at 10 ppb in groundnuts subjected to further processing and at 4 ppb in groundnuts intended for direct human consumption (this category includes cereals, edible nuts, dried and preserved fruits). It also established a level for aflatoxin M1 which is usually present in milk at .05 ppb.

As noted in Henson et. al (2000), the draft the Commission's regulation on aflatoxins triggered serious concerns among exporters of food products subject to the proposed directive. Exporting countries including Bolivia, Brazil, Peru, India, Argentina, Canada, Mexico, Uruguay, Australia and Pakistan requested that the European Union provide the risk assessments on which it had based its proposed standard (WTO, G/SPS/R/12, 1998). In comments submitted to the WTO a representative of the Gambia maintained that the proposed standard would "effectively restrict entry of the Gambia's groundnuts and essentially the groundnuts from producer countries in the developing world to the European Union" (WTO, G/SPS/GEN/50, 1998).

Peru emphasized that the measure constituted an unjustifiable trade barrier and a violation of the Agreement on Sanitary and Phytosanitary Standards (WTO, G/SPS/R/14, 1999). India also raised concerns about the implications of the new regulation. In its submission to WTO, India stated that "in the case of milk it is understood that the calculation for aflatoxin composition for all contaminants/pesticides are based on the maximum consumption figures of 1,500 grams per person per day, which is 7-8 times higher than the world's per capita consumption of milk. Such an evaluation based on exaggerated assumptions would naturally result in unrealistic and impractical standards leading to creation of non-tariff trade barriers" (WTO, G/SPS/GEN/55, 1998).

Several Asian countries also expressed concern about the impact of the regulation on exports of cereals. Thailand had previously suffered from considerable losses in corn exports as a result of high levels of aflatoxins, and requested EU assistance to developing countries that export products subject to the new regulation (WTO, G/SPS/GEN/57, 1998).

The sampling procedure mandated in the Commission's standard is noteworthy. Sampling is one of the most important contributors to the variability of analyses and identification of aflatoxin contamination due to the non-homogeneous nature of aflatoxin distribution in foods. The EU regulation is similar to the Dutch Code (3x10 kg) which requires that three tests are conducted on a randomly drawn 30 kg. Each sample has to pass the three tests before the shipment is allowed to enter the market. In the case of bulk raw nuts the implementation of this procedure presents difficulties because, as noted earlier aflatoxin is not evenly distributed throughout an entire batch.

Regulations currently under discussion by CODEX, would require that the average aflatoxin levels in the samples meet the standard, rather than each sample independently. The U.S. also requires that the average aflatoxin levels in the three samples meet the standard (U.S. groundnuts industry. Interview on 9th August 2000). Under the proposed CODEX regulations three samples that have levels of aflatoxins equal to 20 ppb, 10 ppb, and 15 ppb would be accepted. The same samples could lead to the rejection of a whole shipment under the new EU regulations.

As a result of the objections raised by EU trading partners, the European Commission decided to relax the proposed aflatoxin levels in cereals, dried fruits and nuts (see Table 2). A July 1998 Commission's directive, established the total aflatoxin standard in groundnuts subject to further processing at 15 ppb (8 ppb for B1), in other nuts and dried fruit subject to further processing at 10 ppb (5 ppb for B1). It established a more stringent standards on cereals and dried fruits, and nuts intended for direct human consumption at 4 ppb (2 ppb for B1). According to the directive, EU members are to implement the necessary laws to comply with the new standards no later than 31 December 2000. For 8 EU members (Belgium, Greece, Ireland, Italy, Luxembourg, The Netherlands, Spain, Sweden) the new directives meant that they must reduce the acceptable aflatoxin levels in their imports of groundnuts by more than 50 percent.

While the European Commission established a 4 ppb levels for total aflatoxins in cereals, dried fruits, and nuts intended for direct human consumption, it set the standard for aflatoxin B1 at 2 ppb for food products intended for direct human consumption (See Table 2). These levels are significantly more stringent than those set by CODEX, which does establish a standard of B1 but assumes that 50-70 percent -- or around 7.5-10.5 ppb of the total aflatoxin level of 15 ppb -- is usually accounted for by aflatoxin B1 contamination.

The new Commission's standard for total aflatoxin contamination in dried fruits and nuts subjected to further processing is the same as that recommended by the CODEX. The Australian standard for total aflatoxins in groundnut is set at 15 ppb. The United

States adopts 20 ppb as the maximum level for the contaminant in various agricultural and food products. What sets the new Commission's standard apart from international standards and those in other developed countries and produces a more stringent regulatory effect is the specific standard set for aflatoxin B1 and the sampling procedures outlined above.

Therefore, the international standard suggests that products which contain levels of aflatoxin B1 as high as 10 ppb would be acceptable for all types of food products. This is true if the total level of aflatoxins does not exceed 15 ppb. Similarly, U.S regulations, which set a 20 ppb standard for all types of groundnuts, would effectively allow B1 contamination levels that are as high as 14 ppb. Moreover, the FAO has recommended that testing a single 20 kg sample for aflatoxin content would yield results that are reliable enough to eliminate the risk for the consumer and that stricter requirements would not bring more significant safety measures (Saquib, 2000).

III. Dependency of African Food Exports on the European Market and Compliance Cost of Aflatoxin Standards

Western Europe and other high-income countries are the major export destinations for developing countries through 1995. Table 3 illustrates the dependency of developing country food exporters on developed country's markets. It further indicates that, Western Europe is the major destination for exports from the Middle East and Africa, with a share of 57 percent compared to only 16 percent of trade between countries in these regions. High-income Asian countries, Australia, New Zealand and North America are major destinations of middle and low-income countries in Asia. Latin America has diversified its export markets more than the other developing regions. Africa and the Middle-East are likely, therefore, to be strongly affected by regulatory reforms in European import markets due to their high dependency on these markets.

Developing countries are vulnerable to regulatory changes in developed countries also due to a relative scarcity of public resources to finance compliance with new and more restrictive sanitary and phytosanitary standards. While middle-income developing countries have shifted their export to processed food, countries in the lowest income region such as Africa still largely depend on raw food exports (Ng and Yeats, mimeo). Furthermore, as Finger and Schuler (mimeo) note, the cost of compliance with WTO obligations related to the WTO Agreement on Sanitary and Phytosanitary Standards in the least developed countries can exceed total government budgets for all expenditures. For example Sub-Saharan Africa (SSA) is the least developed region in the world. Gross Domestic Product (GDP) Per Capita (mean) in 1990 was $510. Thirty-eight out of 50 SSA countries fell into the lowest income group of the World Bank's classification in 1999. Fast technological changes have enhanced inspection capacities in developed countries and allowed them to adopt progressively more restrictive sanitary and phytosanitary standards. Securing sales in these major markets is expected to become more challenging and costly over time.

While no estimate of compliance costs to food safety regulation is available, the U.S. groundnut industry has estimated that complying with the EU sampling method would result in an additional US $150 cost per lot (a lot contains on average 16 tons) for raw groundnuts. It has also estimated that the method would lead, on average, to rejection of 30 percent of U.S. groundnuts exports (National Peanut Council of America, Memo to the Ministry of Agriculture, Fisheries and Food. April 18, 1997). Estimates of cost and rejection based on these data sets are likely to be much higher for African countries (National Peanut Council of America, Memo to the Ministry of Agriculture, Fisheries and Food. April 18, 1997). Moreover, Australia maintained, in a submission to the WTO, that "the proposed sampling procedure is unduly onerous and likely to be costly." Under the proposed sampling plan it is estimated that up to 75 per cent of lots rejected would be "good lots" (WTO, G/SPS/GEN/61, 1998).

IV. Empirical analysis

There is a limited number of studies that have used empirical data to estimate the trade effect of standards. Quantifying standards entails greater complexity since standards affect market demand and supply in various ways. Unlike tariffs, change in the equilibrium price cannot be predicted unless knowing how import demand and export supply shift, which are functions of many factors such as compliance costs and change in consumer's preference associated with improved product information and quality (Hooker and Caswell, 1999; Maskus and Wilson, in press). A partial equilibrium approach has primarily been employed to analyze the demand, supply and welfare effect of standards (Paarlberg and Lee, 1998; Calvin and Krissoff, 1998). These studies, however, assume a hypothetical relationship between food safety, demand, and supply as compliance costs and preference changes were not directly measured. Antle (1999) developed a cost function approach to estimate specific cost element of compliance.

Econometric approaches have been used to estimate the effect of standards on trade flow (Moenious, 1999; Otsuki, Wilson and Sewadeh, mimeo). While a direct impact of standards on trade flow can be estimated, the application of results to policy making is limited. This is due to the fact that simple counts of standards are used to capture the severity of standards. Otsuki, Wilson and Sewadeh instead employ a direct measure of the severity of food safety standards expressed in maximum allowable contamination in their econometric analysis. The severity of standards was therefore comparable across countries and results better suited as input to policy discussions.

We use an econometric approach to determine the effect of European aflatoxin standards on African exports. The framework in our empirical study follows the gravity-equation model that was developed in Otsuki, Wilson and Sewadeh. A gravity-equation model is a widely used method to explain trade patterns between countries using each country's measures of 'mass' and geographical distance between countries. In most countries, aflatoxins standards on foods, for example, are specified for both aflatoxin B1 alone, and total level of aflatoxins B1, B2, G1 and G2 (See Table 1). In practice passing the B1 standard is more difficult than passing the standard for the total level of aflatoxins. This is the standard that is more likely to affect trade flows.

Our specification of gravity equation is as follows:

$$ln(M_{ij}^k) = b_0+b_0^k+b_1^k ln(PCGNP_i) + b_2^k ln(PCGNP_j) + b_3^k ln(DIST_{ij}) + b_4^k YEAR + b_5 COL_{ij} + b_6 ln(STi^k)+ \varepsilon_{ij}^k \qquad (1)$$

where M_{ij}^k denotes value of trade from African country *j* to EU country member *i*. It is obtained from trade data of the United Nations Statistical Office. Trade data includes bilateral trade value across time. We use data for the time period between 1989 and 1998. Parameter *b*'s are coefficient. *PCGNP* is real per capita GNP in 1995 US dollar. *DIST* is geographical distance between country *i* and *j*, and *YEAR* is a year. *COL* is colonial tie dummy. It equals one if a colonial tie between country *i* and *j*, exists, and is zero otherwise.

ST_i^k is maximum aflatoxin level imposed on import of food product, *k*, by EU importing country *i*. It is obtained from FAO survey of mycotoxin standards on food and feed stuffs in 1995 (FAO, 1995). While not explicated, dummies for exporting countries are included in order to control for unobserved factors such as production environment and product quality that may vary across these countries. The term ε_{ij}^{k} is the error term and is assumed to be normally distributed with mean zero.

We selected product categories for examination where data are available. We first conduct the analysis at an aggregate level that is defined by two digit under the STIC Revision 2 classification. The value of trade of 'cereals and cereal preparations' and 'fruits, nuts and vegetables' are regressed on the variables presented above.

United Nations trade data for 15 European countries and 9 African countries are used. The European countries include Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, and United Kingdom. The African countries include Chad, Egypt, the Gambia, Mali, Nigeria, Senegal, South Africa, Sudan, and Zimbabwe. A fixed-effect model for importing countries as cross-sectional groups is used since the error term is considered to reflect common characteristics within a group of observations associated with each country.

We show in Table 4 that standards for aflatoxin B1 have significant negative effects on trade flows of both cereals and fruits, nuts and vegetables. It suggests that there are some sub-product-categories in both groups that were sensitive to the standards. In particular, most cereals were subject to the aflatoxins standards according to the FAO survey. Since a double-log specification is used, the coefficient of a variable can be interpreted as elasticity, and the greater coefficient estimate for cereals perhaps reflects this fact. The result implies that a 10 percent tightening of the aflatoxins standards (a 10 percent smaller maximum level of contamination) will reduce trade flow by 14.3 percent for cereals and 3.0 percent for fruits, nuts and vegetables.

Table 4 also suggests that colonial ties have significant positive implication for trade. The effect is greater for fruits and vegetable perhaps because they were specifically produced for exports (such as tropical fruits and nuts) under colonial rule. The result is consistent with the result found in the case of Europe-Africa groundnuts trade in Otsuki, Wilson and Sewadeh. For example, Egypt, the Gambia, South Africa, Sudan, and Nigeria have tendency to export to the United Kingdom, while Mali, Senegal and Chad have tendency to export to France. Language and cultural assimilation, historical trade relationships may have created strong dependency on the market in countries that had colonial ties (Otsuki, Wilson and Sewadeh). These factors can possibly appear as non-market barriers and separating their effect from standards is necessary. Thus, colonial ties appear to have important implications for these predicted results.

The 'fruits, nuts and vegetables' category includes fresh, dried and preserved fruits and vegetables. Dried and preserved fruits, nuts and vegetables have been a particular focus of aflatoxin regulations since drying and preserving processes tend to grow fungus that contain aflatoxins. Consequently, we repeated the analysis under a greater disaggregation of these product categories. We focus on dried and preserved fruits, groundnuts and other nuts.

Table 5 shows the elasticity of aflatoxin B1 standards on trade flows in different product sub-categories. The table suggests that the standards' effect is significant both on groundnuts and the other nuts, while the magnitude of the effect is greater on groundnuts reflecting a greater sensitivity of groundnuts trade to aflatoxin standards than the other nuts. It also indicates that the standard's effect on 'dried or preserved fruits' is significant. Thus, products under the category of 'fruits, nuts and vegetable' that are of the focus of the

Commission's new regulation are expect to be affected when this regulation comes into force.

V. Simulations

This section provides results on how trade flows between Africa and Europe would differ under conditions in which (1) a standard developed using CODEX guidelines were imposed or (2) the European harmonized standard is imposed on African exports. The predicted trade flow in value under both scenarios is computed for each EU and African country for products analyzed in the previous section. An upper and a lower bounds for change in trade flow are imposed in order for the result to reflect the non-negative export and the capacity constraints on exports; i.e., trade flow will not increase or decrease by more than 100 percent.

As noted, CODEX does not set standards on aflatoxin B1 alone. In order to establish a baseline estimate for an international standard, we assume the 9 ppb for the studied products based on the standard on the level of total aflatoxins contamination (15 ppb). Composition of aflatoxin B1 in all aflatoxins in food can vary across products and samples. The variation is normally between 50 to 70 percent. We assume, therefore, that 60 percent of all aflatoxins are in fact aflatoxin B1 by adopting the average of these two bounds. Given this assumption, aflatoxin B1 contamination should be below 9 ppb in order to sustain total aflatoxins below a 15 ppb level.

Cereals exhibit a significant difference between the two scenarios. As shown in Table 6, the predicted loss of cereals trade flow under the Commission's new standard is US$ 177 millions[6], or 59 percent lower than the value of EU-Africa cereal trade in 1998. The predicted total trade flow under the Commission's new standard US$ 120 millions or

76 percent lower than that under the CODEX standard-- US$ 500. Among the EU countries, Austria alone is estimated to have an increase in imports since it had a lower aflatoxin B1 standard in prior to 1998. France is estimated to decrease cereals imports by the largest magnitude of US$ 92 million under the new Commission's standards from the predicted value based on the 1998 trade.[7]

As shown in Table 7, the predicted value of trade flow of dried and preserved fruits and edible nuts under the Commission's new standard is US$ 220 million[8] or 47 percent lower than the trade of these products in 1998. The estimated trade flow under the Commission's new standard is US$252 million, which is 53 percent lower than that under the assumed level of CODEX standard—US$ 539 million. Countries that had more lax aflatoxin B1 standard than the CODEX standard exhibit great deviations of trade flow from the CODEX case.

These trade losses are estimated only for European and African countries. This simulation does not predict these countries' response of diverting trade partners. European countries is in particular likely to shift their food imports from Africa to other countries while they may have to pay higher prices than they did for African exports. African countries may not be able to find alternative markets outside Europe due to their high dependency on the European market. They will then have to chose whether to bear higher costs for transportation and accession to new markets or to invest in compliance to the new standards. This simulation also does not consider African countries' potential benefits from compliance. If African countries are able to comply with the European standards, liver cancer deaths of African population would decrease as well. These benefits will offset the export losses. While these issues are of great interest, they are beyond the scope of this simulation analysis.

VI. Implications

This paper examines impact of sanitary and phytosanitary standards on flow of food trade between Africa and Europe. A regression approach estimated the elasticity of aflatoxin standards on the value of trade flows from 9 African countries to 15 European countries. The result suggests that cereals, dried fruits and edible nuts trade are negatively affected by aflatoxins standards in Europe before the new European Commission's harmonization of aflatoxins standards. A 10 percent lower maximum allowable level of contamination will reduce trade flow by 11 percent for cereals, 4.3 percent for fruits, nuts and vegetables. Among fruits, nuts and vegetables, groundnuts are found to be highly sensitive to the aflatoxin standards, a 13 percent reduction for the same change in the standard.

The simulation is performed under two regulatory scenarios (1) an international standard indicated by guidelines set by CODEX and (2) the Commission's new standard. It is found that the Commissions' standard will impose a considerable loss of export revenue in African countries. In particular, the Commission's standard will impose far greater trade impediments when compared with trade under an international standard for cereals and edible nuts trade. African export revenue from the 15 European countries is estimated to decrease by 59 percent for cereals and 47 percent for dried and preserved fruits and edible nuts. The total loss is estimated to be nearly US$ 400 million for cereals, dried and preserved fruits, and nuts under the Commission's new standard. Trade flow of these products is found to increase by nearly US$ 700 million if a standards is imposed based on an extension of current CODEX international standards.

Our results suggest several areas for consideration in a public policy context. One implication of the new standard on aflatoxins in Europe is the potential application of the risk reduction level to other contaminants in food. The EU directive was developed based on the JECFA risk assessment used by CODEX to establish a less stringent international standard. The fact that the EU decided to regulate aflatoxin B1 directly to achieve deaths risk reduction is not without cost. The JECFA risk assessment can suggest that 0.2 death per billion risk reduction will be achieved by reducing the aflatoxin B1 maximum allowable level by 1 ppb[8], which implies for the case of cereals, dried and preserved fruits and edible nuts that 1.4 deaths per billion risk reduction will be achieved under the Commission's new standard (2 ppb) as opposed to the level that follows the CODEX guideline (9 ppb). This estimated reduction of liver cancer is small compared to the total number of deaths of liver cancer in the EU. WHO estimates approximately 33,000 people die from liver cancer every year in EU which has population of half billion.

The standard is also relevant in consideration of obligations in the WTO SPS Agreement. The Agreement recognizes the rights of member countries to determine the "appropriate levels of protection" of human health. The level set by Europe and our findings on the magnitude of the trade effect, however, raise important questions for consideration. These include the costs of a proliferation of national standards set in absence of CODEX setting an internationally agreed level for B1 directly, as well as how the WTO addresses the economic trade-off of individual interpretations of "appropriate protection" and "least trade distorting" in SPS cases with the type of empirical work now being conducted in analyses such as this one.

Finally, our results suggest several areas for further empirical research and extension of the analysis. A gravity-equation model is unable to disentangle demand and supply effect of standards. The application of a system of equations with unit prices would make welfare analysis feasible. The utility gain of consumers in the importing countries can thus be estimated and compared with welfare losses from the exporting countries. A dynamic of consumers and exporters' decision could also be considered in the model framework used in this paper. Compliance involves one-time costs of product re-design and building an administrative system as well as recurrent costs of maintaining quality control and testing and certification (Wilson and Maskus, in press). Consumers' response also can better be modeled by incorporating their dynamic behavior since their current purchase decisions are typically influenced on their perception of product quality and safety that is characterized through repeated purchases.

Endnotes

[1] Henson, Spencer, et al, 2000. Impact of Sanitary and Phytosanitary Measures on Developing Countries. University of Reading, p 10.

[2] United National Development Programmes.

[3] Food and Agriculture Organization.

[4] World Health Organization.

[5] JECFA estimated that implementing a 10 ppb total aflatoxin standard, population potency is 39 cancer deaths per year per billion people, with uncertainty range between 7 and 164 people. In comparison, a 20 ppb standard will yield potency rates equal to 41 cancers per year per billion people with uncertainty range between 8 and 173 cancer deaths. This implies that the 20 ppb standard will lead to 2 additional cancer deaths per billion people compared to the 10 ppb standard. The estimates assumed a population with 1 percent carriers of hepatitis (i.e. European population) and used potency values equal to .3 cancers per year per 100,000 people among carriers of Hepatitis B and .01 cancers per year per 100,000 population among noncarriers.

[6] This number is under estimation based on the United Nations trade statistics.

[7] It should be noted, however, that it had standards on other micotoxins that may be much stricter than the aflatoxins on cereals. These micotoxins include searalenone and ochratoxin (FAO, 1995). Standards on these chemicals may remain after the EU standards harmonization. If so, the estimated decrease may be smaller in magnitude.

[8] This number is under estimation based on the United Nations Trade Statistics.

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Figure Captions

Fig. 1. Share of food exports in total exports

Table Captions

Table 1. Maximum allowable aflatoxin levels in Europe and Africa (ppb)

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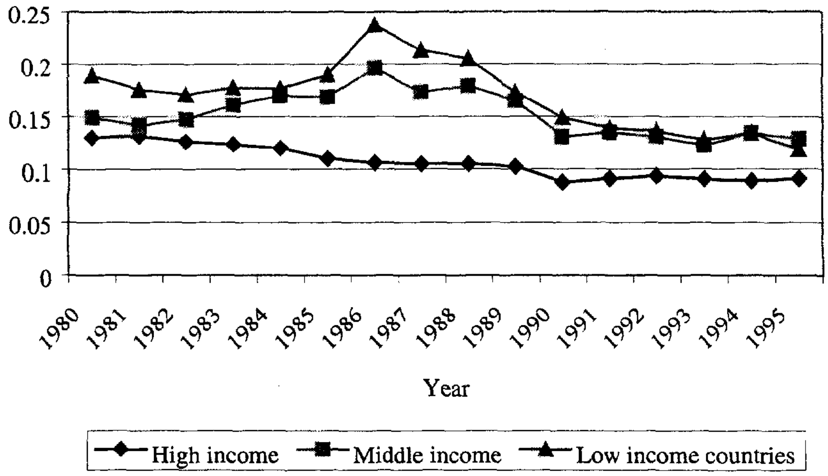
Fig. 1. Share of food exports in total exports



Source: World Bank calculations, based on GTAP

Table 1. Maximum allowable aflatoxin levels in Europe and Africa (ppb)

Country	Commodity	Aflatoxin B1	Aflatoxin Total
Austria	all foods	1	na
	Milling and shelled products and derived food	2	na
Belgium	Groundnuts	5	na
Denmark	Groundnuts	2	4
	brazil nuts	2	4
	dried figs	2	4
Finland	all foods	na	5
France	all foods	10	na
	Groundnuts	1	na
	wheat meal	3	na
	wheat bran	10	na
	Vegetable oils, cereals, wheat meal	5	na
Germany	all foods	2	4
	Enzyme	na	0.05
Greece	nuts and edible seeds	5	10
	dried fruits	5	10
Ireland	all foods	5	30
Italy	all foods	5	10
	dried figs	5	10
	Spices	20	40
Luxembourg	Groundnuts	5	na
The Netherlands	all foods	5	na
Portugal	all foods	20	na
	Groundnuts	25	na
Spain	all foods	5	10
Sweden	all foods	na	5
United Kingdom	nuts, dried figs	na	4
	Groundnuts, copra, palm-kernel, cotton seed	20	na
Norway (EEA)	all foods	na	5
	brazil nuts	na	5
	mixed foodstuffs depending on animal	50	na
Africa	Groundnuts	14	44

Source: FAO (1995)

Table 2. The European Commission's proposal of maximum allowable aflatoxins levels

		Aflatoxins: maximum admissible levels(1) (ug/kg)		
	Products	B1	B1 + B2 + G1 + G2	M1
2.1.1	Groundnuts, nuts and dried fruit			
2.1.1.1.	Groundnuts, nuts and dried fruit and Processed products thereof, intended for Direct human consumption or as an Ingredient in foodstuffs.	2(4)	4(4)	–
2.1.1.2.	Groundnuts to be subjected to sorting, or other physical treatment, before human Consumption or use as an ingredient in foodstuffs.	8(4)	15(4)	–
2.1.1.3.	Nuts and dried fruit to be subjected to Sorting, or other physical treatment, Before human consumption or use as An ingredient in foodstuffs.	5 (4) (5)	10 (4) (5)	–
2.1.2.	Cereals (including buckwheat, *Fagopyrum sp.*)			
2.1.2.1.	Cereals (including buckwheat, *Fagopyrum sp.*) and processed products Thereof intended for direct human Consumption or as an ingredient in Foodstuffs.	2	4	–
2.1.2.2	Cereals (including buckwheat, *Fagopyrum sp.* To be subjected to sorting, or Other physical treatment, before human Consumption or use as an ingredient in Foodstuffs.	–	–	–
2.1.3	Milk (raw milk, milk for the manufacture of milk-based products and heat-treated Milk as defined by Council Directive 92/46/EEC of 16 June 1992 laying down The health rules for the production and Placing on the market of raw milk, heat-treated Milk and milk-based products.	–	–	0,05

Source: Commission Regulation No. 1525/98

Table 3. Food exports by destination regions in 1995 (1995 US$ million)

	West Europe	Rest of high Income countries	Middle East/ Africa	Asia	Latin America	Rest of the world	Total
West Europe	152,348 **(0.74)**[1]	16,609 **(0.08)**	13,545 **(0.07)**	4,944 **(0.02)**	3,832 **(0.02)**	13,781 **(0.07)**	205,059 **(1.00)**
Rest of high income Countries	13,432 **(0.13)**	48,868 **(0.47)**	8,647 **(0.08)**	19,318 **(0.19)**	9,602 **(0.09)**	3,077 **(0.03)**	102,943 **(1.00)**
Middle East/Africa	14,855 **(0.57)**	3,123 **(0.12)**	4,031 **(0.16)**	1,985 **(0.08)**	298 **(0.01)**	1,576 **(0.06)**	25,868 **(1.00)**
Asia[2]	9,030 **(0.15)**	26,218 **(0.44)**	5,312 **(0.09)**	15,039 **(0.25)**	982 **(0.02)**	3,341 **(0.06)**	59,922 **(1.00)**
Latin America	17,969 **(0.33)**	17,421 **(0.32)**	3,955 **(0.07)**	3,830 **(0.07)**	9,073 **(0.17)**	1,844 **(0.03)**	54,082 **(1.00)**
Rest of the world	7,919 **(0.41)**	2,935 **(0.15)**	1,263 **(0.07)**	2,232 **(0.11)**	256 **(0.01)**	4,817 **(0.25)**	19,422 **(1.00)**

Source: World Bank calculations, based on GTAP

Notes:

1-inside parentheses are shares in parentage in total value of exports from a given region. The regions in the first column are origins of export of food products, and the regions in the first row are destinations for these products

2-excluding Hong Kong, Japan, South Korea and Taiwan, which are included in the rest of high income countries.

Table 4. Regression results on the value of export from Africa under the SITC 2-digit level (the double-log specification)

Products	Cereals and cereal preparations		Fruits, nuts, and vegetable	
	Coefficient	t-value	Coefficient	t-value
Constant	63.4272	0.706	38.3051	0.817
GNP per capita in Europe	1.4254**	2.665	3.0476**	11.618
GNP per capita in Africa	-0.9890	-1.028	0.9378*	1.769
Geographical distance	-4.8551**	-4.201	-3.6408**	-7.323
Aflatoxin B1 Standards	1.0517**	4.144	0.4327**	4.008
Year	-0.0132	-0.285	-0.0184	-0.779
Dummy for colonization ties	2.1195**	4.866	3.2571**	14.316
Number of observations	346		865	
Adjusted R-squared	0.2566		0.6636	

Note: 1. Fixed-effect models for importing countries are estimated.

2. '*' and '**' imply significance at the 10 and 5 percent levels under a two-tail test, respectively.

Table 5. Elasticity of aflatoxin B1 standards on value of export from Africa

	Elasticity of standards
Cereals and cereal preparations	1.0517**
Fruits, nuts and vegetables	
Coconuts, Brazil and cashew nuts	0.7419*
Groundnuts and other edible nuts	1.2950**
Dried or preserved fruits	0.7705**

Note: '*' and '**' imply significance at the 10 and 5 percent levels under a two-tail test, respectively.

Table 6. Comparison of predicted trade flow under alternative scenarios: cereals and cereal preparations from Africa (US$ million)

	The Value of import in 1998	Predicted change in the value of import		Predicted value of import		Difference between the the two scenarios (%)
		EU standard	CODEX standard (assumed level)	EU standard	CODEX standard (assumed level)	
	(US$ million)	(US$ million)	(US$ million)	(US$ million)	(US$ million)	(%)
Austria	5	+5	+5	10	10	0
Belgium -Luxembourg	16	-10	+13	6	29	80
Denmark	5	+0	+5	5	11	50
Finland	3	-1	+3	2	5	61
France	146	-92	+123	54	270	80
Germany	10	0	+10	10	20	50
Ireland	5	-3	+4	2	9	80
Italy	35	-22	+29	13	65	80
Netherlands	13	-8	+11	5	24	80
Norway	na	na	na	na	na	na
Portugal	37	-35	-22	2	16	87
Spain	16	-10	+13	6	29	80
Sweden	3	-1	+3	2	6	61
U.K.	3	0	+3	3	7	50
EU	298	-177(-59%)	+202(+68%)	120	500	76

Table 7. Comparison of predicted trade flow under alternative scenarios: Dried fruits, and nuts from Africa

	The Value of import in 1998	Predicted change in the value of import		Predicted value of import		Difference between the the two scenarios (%)
		EU standard	CODEX standard (assumed level)	EU standard	CODEX standard (assumed level)	
	(US$ million)	(US$ million)	(US$ million)	(US$ million)	(US$ million)	(%)
Austria	6.3	+4.9	+6.3	11.2	12.6	11
Belgium -Luxembourg	13.4	-7.1	+9.3	6.4	22.7	72
Denmark	7.4	0.0	+7.4	7.4	14.9	50
Finland	2.9	-0.6	+2.9	2.4	5.8	60
France	361.5	-177.0	+8.2	184.5	369.7	50
Germany	10.9	0.0	+10.9	10.9	21.8	50
Ireland	3.7	-2.3	+3.0	1.4	6.7	80
Italy	17.4	-8.6	+11.4	8.8	28.8	70
Netherlands	10.8	-5.9	+7.7	5.0	18.6	73
Norway	18.5	-17.5	-14.2	1.0	4.3	76
Portugal	6.7	-4.3	+1.7	2.4	8.4	71
Spain	4.5	-1.8	+3.3	2.7	7.8	65
Sweden	4.1	-0.3	+4.1	3.8	8.1	53
U.K.	4.1	0.0	+4.1	4.1	8.3	50
EU	472	-220(-47%)	+66(+14%)	252	539	53

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