The Trade Effects of Phytosanitary Protocols on the U.S.–India Almond Trade

Juma Salim, Sayed Saghaian, and Michael Reed

The United States is a dominant world producer of almonds and is the dominant player in India's market, accounting for an 80–85 percent share. However, U.S. almond imports to India face high tariffs and non-tariff barriers which diminish the full potential of export volume for U.S. almonds. This research uses an empirical model to examine the trade effects of eliminating India's phytosanitary protocols of in-shell almond imports shipped from the U.S. for the years 2003/04 to 2006/07. The model uses a price-wedge analysis incorporating uncertainty as to the outcome of the net revenue in almond exports which adds to the economic cost of the exports. With the elimination of phytosanitary protocols, the results indicate that trade would be increased and much of the increased imports would accrue to U.S. producers. Therefore lessening restrictive import requirements for pest control will normally increase the flow of agricultural products and improve the welfare of consumers. This U.S.-India almond-trade model also can be used to estimate the trade effects of other phytosanitary measures on agricultural products.

Technical barriers are often major obstacles to market access for agricultural exporters. The implementation of phytosanitary measures is an accepted method of protection provided such measures are consistent with the World Trade Organization (WTO) Agreements. Article 5.6 of the WTO Agreement on the application of Sanitary and Phytosanitary (SPS) Measures states that members shall ensure that their measures are not more trade-restrictive than required to achieve their appropriate level of sanitary or phytosanitary protection (WTO 1994). On the other hand, import restrictions that fall short of compliance with international rules are disputable under U.S. trade laws and through the WTO.

The U.S. continues to be the dominant global producer of almonds, accounting for 80 percent of world supply. In 2004 the value of U.S. almond production exceeded $2 billion, making almonds the second-largest fruit and nut crop in the United States, behind grapes (ERS 2005; NASS 2005). Almond production in the United States is limited almost exclusively to California, and remains the leading California agricultural export by value and also the leading U.S. horticultural export (ERS 2004; FAS 2004), accounting for one-third of worldwide shipments. U.S. almond exports reached nearly $1.3 billion in 2004, with the largest export destinations being Spain, Germany, Japan, and India. Almond shipments have increased by 21 percent to Indian markets over the last five years (Borris and Brunke 2005, ERS 2005; NASS 2005).

The U.S. has a dominant market share in India, accounting for around 80 percent of almond imports. While U.S. almond exports continue to grow, substantial expansion in U.S.-India trade of almonds will depend on continued and significant additional Indian liberalization. U.S. almond growers will have an opportunity to increase their almond exports to India if features of sanitary and phytosanitary protocols are eliminated. This study investigates the trade effect of phytosanitary protocols facing U.S. almond exports to India. For analysis of this study, we follow the current India phytosanitary rule that requires in-shell almonds from the United States be fumigated with phosphine before departure. Almond exporters outside of the U.S., Canada, or Mexico must still, however, comply with the phytosanitary protocols of an importing country. The phytosanitary protocols required by India for U.S. almond imports primarily address *Ephestia elutella* (Tobacco moth), *Ephestia kuehniella* (Mediterranean flour moth), and *Plodia interpunctella* (Indian meal moth) (Government of India 2007). We then examine the trade effect when phytosanitary protocols are removed.

Background

U.S. producers encounter high tariff and non-tariff barriers that impede their agricultural exports to

Salim is assistant research professor, Saghaian is associate professor, and Reed is professor, Department of Agricultural Economics, University of Kentucky.

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India (Narayan 2005). India's progress in reducing tariff and non-tariff barriers on agricultural products seems to be negligible. Trade barriers can take a variety of forms, including strict limits for contaminants and pest-infestation tolerances. The results can mean potential obstacles to almond shipments and reduced demand. There is no simple quantitative assessment of the impact of phytosanitary barriers facing U.S. almonds. Beghin and Bureau (2001) presented several methodologies for modeling and quantifying non-tariff barriers (NTBs) to trade in the agricultural and food sectors. Several researchers have used price-wedge model methodologies to measure the cost of phytosanitary barriers. The methodology compares prices in two countries in order to provide a tariff equivalent and assign a residual to the cost of compliance with phytosanitary barriers. The method has several important limitations. First, the price-wedge methodology assumes that the two goods compared are perfect substitutes. Second, it is possible to quantify the effect of NTBs present but is difficult to identify the precise nature of those NTBs. Third, for large-scale studies it is difficult to reflect differences in the quality of imported goods. Fourth, the cost of the SPS barrier is measured as a residual and not as an explicit function of the structure of the phytosanitary protocols.

Campbell and Gossette (1994) used a price-wedge model for a large number of sectors. However, they made quality adjustments that generated homogeneous products. Calvin and Krissoff (1998) addressed the cost of Japanese phytosanitary barriers for U.S. apples by assuming perfect substitution. They estimated the technical-barrier tariff-rate equivalent by comparing CIF (cost, insurance, and freight) prices of U.S. apples in the foreign country with wholesale prices in the foreign market. This basic price-wedge methodology was extended by Calvin, Krissoff, and Foster (2008) by measuring the costs and trade effects of phytosanitary protocols of Japanese apple imports from the U.S. They address the problem by developing separate costs for fire-blight and codling-moth protocols and introduce uncertainty as to the outcome of participation in the export program. Yue, Beghin, and Jensen (2006) also extended the basic price-wedge model by generalizing to the situation where goods are not perfect substitutes. Their investigation was limited to the situation where all phytosanitary protocols are removed.

Methodology

This analysis addresses the problem of how to develop costs and trade effects for phytosanitary protocols of Indian almond imports from the U.S. by measuring the actual cost of the phytosanitary barriers (Beghin and Bureau 2001; Calvin, Krissoff, and Foster 2008; Peterson and Orden 2006). We first develop a simple export model that directly links the cost of phytosanitary barriers to the requirements of the protocols and incorporates the U.S. almond-grower's decision about whether to export to the Indian market. The analysis of the problem introduces uncertainty in net revenue in exporting almonds to India which adds to the economic cost above the accounting cost. To simplify the analysis, a perfect substitution is assumed. For example, if imports are a poor substitute for domestic goods, the percentage increase in price of an import good due to an imposed technical barrier will increase less in the domestic market because there will be differences in the price elasticity of demand and supply between domestic and imported good. The price-wedge method will also reflect rents rather than technical barriers if exporters are able to price discriminate (Beghin and Bureau 2001). We describe the export-trade models which provide estimates of the expected net revenues for different outcomes of a grower's decision to export or sell in the domestic market (Calvin, Krissoff, and Foster 2008). These estimates provide the basis for investigating the trade effects of eliminating phytosanitary barriers.

To estimate the change in Indian almond imports, the analysis uses a static, partial-equilibrium trade model developed by Calvin, Krissoff, and Foster (2008) (see Equations 7, 8 and 9). The approach in this study is to estimate and separate the economic costs of the Indian phytosanitary barriers in order to concentrate on the effect of removing the protocol.

Model Specification

In this model analysis, we assume 1) the U.S. almond producer faces two options: export almonds to the Indian market, or sell almonds in the domestic market and export to international markets other than India; 2) the almond producer is risk-neutral and expects positive net revenue from exporting to the Indian market; 3) the grower has two types of almonds: high and low quality. The high-quality almonds can be sold in both the domestic and the Indian market, while the low-quality can be sold only in the domestic market; and 4) the distribution of quality is exogenous.

The expected net revenue of producing one pound of almonds, N_r, for the risk-neutral producer who decides to sell only to the domestic market depends on domestic prices, the quality of almonds, and production costs:

$$(1)\ N_r = aP_d + (1-a)P_b - C,$$

where a is the probability of producing high-quality almonds, P_d is the expected price of high-quality almonds per pound in the domestic market, P_b is the expected price per pound of low-quality almonds in the domestic market, and C is the production cost of almonds per pound.

The expected net revenue, E_r, for the U.S. almond producer who exports to India must consider the probability that almonds produced will be of high quality (a), suitable for Indian export. Assume that an almond producer would receive an expected price of P_i per pound if the almonds were sold to India. Let q represent the expected proportion of high-quality almonds shipped to India. Therefore the expected net revenue (E_r) to export to India will be achieved with the probability of having high-quality almonds and the proportion of expected shipment quantities (a and q):

$$(2)\ E_r = a\{[qP_i + (1-q)P_d] - [C + qC_{PH}]\},$$

where C_{PH} is the cost of phosphine fumigation.

If the almonds produced are of low quality, a producer cannot export to India and does not incur any expense for post-harvest treatment. The expected net revenue L_r will be

$$(3)\ L_r = (1-a)(P_b - C).$$

Equations 2 and 3 will give the expected net revenue N_X for exporting almonds to Indian market.

$$(4)\ N_X = aq(P_i - P_d) + aP_d + (1-a)P_b - (C + aqC_{PH}).$$

For the risk-neutral producer to be enticed to export to India, the expected net revenue N_X must at least equal the expected net revenue of selling in the domestic market N_r after correction for transaction costs. Therefore a producer would export to India if the expected export price equals or exceeds the expected price of high-quality almonds for the domestic market, including expected costs of phosphine fumigation and other accounting costs:

$$(5)\ N_X - N_r = aq(P_i - P_d) - aq(C_{PH}) \geq 0,$$
$$P_i \geq P_d + C_{PH'} + t,$$

where t represents transaction costs including insurance, freight, and other administrative costs.

To deliver the high-quality almonds to the Indian domestic wholesale market, wholesalers require the minimum price P_{IM} which accommodates P_i and Indian tariff-rate equivalent v after correction for internal transaction costs:

$$(6)\ P_{IM} = P_i(1+v) = (P_d + C_{PH'} + t)(1+v).$$

The Indian Government receives the tariff revenue, handlers and other institutions receive t. If the non-tariff barriers were removed, the minimum price (P_i^*) of high-quality almonds produced under U.S. standard almond industry practices would equal the Indian domestic wholesale price P_{IM} and trade would increase.

(7) If $P_{IM} < (P_d + t)(1+v) + C_{PH'}(1+v)$, then there is no trade ($T = 0$),
If $P_{IM} \geq (P_d + t)(1+v) + C_{PH'}(1+v)$, then there is trade ($T > 0$).

$$(8)\ I = D(P_{IM}) - S(P_{IM}),$$

where I is the total Indian imports from all sources including the U.S., D is India's consumer demand, and S is India's domestic supply. If the government of India removes its almond phytosanitary protocols and accepts the U.S. standard free from pest, the change in Indian imports of almonds can be determined by differentiating equations 7 and 8 (Calvin, Krissoff, and Foster 2008):

$$(9)\ dI = \epsilon_D D\left(\frac{(1+v)dC_{PH}}{P_{IM}}\right) - \epsilon_S S\left(\frac{(1+v)dC_{PH}}{P_{IM}}\right),$$

where dI is the change in almond imports, ϵ_D and ϵ_S are the price elasticities with respect to demand

and supply, and $(1 + v)dC_{PH}$ is the change in the P_{IM} with changes in phytosanitary protocols. When the phytosanitary protocols are removed, the domestic wholesale price (P_{IM}) in India falls to the minimum price (P_i) plus the tariff. In this case consumers gain, producers lose, and the government continues to receive the tariff revenue.

Data

The average estimated cost of phosphine fumigation in the U.S. is $0.0027 per pound (Aegerter and Folwell 2001). The average annual CIF (cost, insurance, and freight), a proxy for the world almond price, was estimated from the invoice prices paid by the domestic importers to the U.S. exporters, exclusive of tariffs. The average value of the CIF at the port of India for almonds produced in the U.S. was calculated at $1.30 per pound. The Indian average wholesale market price (Delhi Market) is $2.19 per pound (ERS 2007a; FAS 2007). The applicable tariff value for almond in India is $0.67 per pound (Singh 2002–2007). The average tariff-rate of phytosanitary protocol is 51.8, which is the residue when the price difference is corrected for tariff, handling, and transportation costs to domestic wholesale markets. Due to data limitations, the internal transaction costs to move almonds to domestic wholesale markets were assumed to be $0.22 per pound. For this study, price elasticities of demand and supply were calculated because estimated data from previous studies were not available (Table 1). They are generally inelastic except the price elasticity of demand for the marketing year of 2006/07.

The expected export shipment was based on the relationship of production and export quantities (Almond Board of California 2007a; 2007b). The average proportion of almond shipments (q) to India was estimated at 0.69. The quality suitable for the export market (a) was based on inspection reports in the U.S. (Almond Board of California 2007a, 2007b). This quality parameter was estimated at 0.98.

Empirical Results

The almond trade is estimated in the absence of the phytosanitary protocol, so that its cost is assumed to be zero. This empirical model looks at the effect of eliminating phytosanitary protocols in the almond trade from marketing years 2003/04 through 2006/07. The technical barrier (TB) tariff-rate equivalent varies between years and the average over several years was estimated at 51.8 (Table 1). The TB tariff-rate equivalents were slightly higher in the earlier years. Table 1 shows the quantity and value of trade that would have increased if phytosanitary protocols were eliminated. In this case, India could import almonds at the world price minus the phytosanitary costs.

The range of annual and average quantities and values for the short-run effect of eliminating the phytosanitary protocols are shown in Table 1. The average quantity of almonds imported would increase by 9,219 metric tons, with a value of $51.1 million. India's consumption of almonds is almost

Table 1. Short-Run Changes in India's Almond Imports with the Elimination of Phytosanitary Protocols.

		Elasticities of		Increased imports with the elimination of TB	
Year	TB tariff-rate (%)	Demand	Supply	Quantity (MT)	Value ($)
2003/04	60.8	-0.075	-0.041	1,305	5,106,401
2004/05	51.1	0.135	0.243	2,149	11,551,533
2005/06	53.1	-0.897	0.268	10,508	65,283,117
2006/07	42.4	-1.383	-0.289	22,913	122,649,582
Average	51.8			9,219	51,147,658

entirely met through imports, with the U.S. typically enjoying an 80–85 per cent share of the Indian almond import market (ERS 2007a, 2007b). As the increased trade is the estimate of the total Indian imports from all sources, we assume that the larger share of the increased imports would accrue to the U.S. producers.

The Indian price elasticities of demand and supply were inelastic for the first three marketing years but elastic for the fourth marketing year. As trade would be increased with the elimination of phytosanitary protocols, almond consumers in India would gain at the expense of producers. While the increased imports would allow Indian producers to change their production plans in response to new economic conditions, the producer supply curve might change when faced with new competition. As these changes take place, the Indian almond industry would have incentive to improve production technology and reduce production costs, which would increase producer surplus.

Conclusion

This study focuses on the trade effects of phytosanitary protocols on the U.S. producers for the Indian market and U.S. almond sales to India. This analysis is critical for understanding the impact of phytosanitary protocols on U.S. almond producers. The model provides explicit derivation of the cost in terms of phytosanitary protocols. With the elimination of phytosanitary protocols, almond trade increased. The U.S. is assumed to accrue a larger share of this increased import since it is the dominant exporter of the Indian market.

While measuring TB tariff-rate equivalents is a simple concept, the results are highly dependent on a number of assumptions, some of which may lead to overestimation or underestimation of TB tariff-rate equivalents and trade effects. We may have overestimated or underestimated the price differentials because almond quality differences were not reflected in this study. The model relies strongly on the assumption of perfect substitution. In addition, the price-wedge calculations did not reflect the actual internal transaction costs of moving U.S. almonds from the Indian port of entry to wholesale markets. This export model of the U.S.-India almond trade also can be used for estimating the trade effects of other phytosanitary measures.

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