Illustration of the Modeling Framework: Economic Effects of the U.S. Ban on Avocados from Mexico

Orden and Romano's work on the economic effects of an SPS regulation provides a useful example to illustrate our modeling framework. To evaluate the economic effects of full or partial easing of a long-standing ban on U.S. importation of avocados from Mexico, they examined the effects on American producers and consumers under alternative assumptions about the probability of a pest infestation affecting domestic production and about the costs of an infestation in terms of pest-control expenses and reduced yields. An initial equilibrium representing the U.S. avocado market was calculated for various estimated supply and demand functions.[31] For Mexican supply, Orden and Romano assumed that export availability was perfectly elastic at the wholesale price ($878/ton) for delivery of avocados from Mexico to New York as calculated by the industry (Garoyan). The assumption of a perfectly elastic supply is analytically plausible for a partial easing of the import ban, as approved by USDA in 1997, but would be an oversimplification for an evaluation of the effects of the quarantine being removed completely, since the expanded trade would then put upward pressure on the Mexican price.

Estimates of the probabilities of pest infestations have been pivotal to the dispute over the legitimacy of the U.S. avocado ban. Firko estimated the trade-related pest infestation probabilities that were used by APHIS. Among four potential pests (fruit flies, seed weevil, stem weevil, and seed moth), he estimated that the maximum probability of an infestation occurring in the United States for partial easing of the import ban under a systems approach to risk mitigation was $\pi_{AM} = 0.00345$, the probability of a pest infestation associated with the introduction of stem weevil. Firko estimated that the probability of infestation of stem weevil had a minimum value $\pi_{Am} = 1.35 \times 10^{-6}$.

Firko's estimates of the probabilities of pest infestations have been considered too low by the domestic industry. Nyrop estimated that the time expected to pass before an infestation of stem weevils occurred under the proposed partial lifting of the ban ranged from less than 1 year to 20 years. Orden and Romano treated the corresponding probabilities of pest infestation due to stem weevils in a particular year as $\pi_{NM} = 1.0$ and $\pi_{Nm} = 0.05$. The four alternative probability estimates from Firko and Nyrop were used to characterize the range of risks of pest infestation (from essentially zero to certainty) that might be associated with complete removal or partial easing of the avocado import ban.

The final parameters affecting the economic analysis were estimates of the costs associated with a pest infestation, which were modeled as a proportional leftward shift in the domestic supply function (as in figure 4). The magnitude of the shift depends on the increase in production costs caused by the pests. Evangelou et al. estimated that weevil infestation would cause a 41-percent increase in marginal cost due to increased application of pesticides and a 20-percent reduction in yield, but considered that those estimates somewhat overstated the likely increase in production costs. Thus, to provide a range of possible results, Orden and Romano considered three possible effects on production costs of a pest infestation centered on the estimates by Evangelou et al. The largest effects were assumed to involve a 60-percent increase in marginal costs and a 20-percent reduction in yield.

For a partial lifting of the U.S. ban on importation of avocados from Mexico, Orden and Romano divided the domestic market into submarkets—the northeastern winter regional market (for which the ban was lifted) and the national aggregate for all other regions and seasons. The domestic price in the northeastern winter regional market was assumed to fall to the

[31] Orden and Romano derived estimates of a linear U.S. avocado supply function that is inelastic in the short run (0.28, when lagged quantity is held constant) and elastic in the long run (1.18, when quantity is in a steady state). Linear estimates of demand were inelastic (-0.45), but reestimation of a nonlinear Box-Cox transformation demand specification (Carman and Cook) yielded a price flexibility of -0.65, corresponding to an elasticity of -1.53. Thus, the estimated supply and demand functions gave point estimates that spanned a range from inelastic to elastic behavioral responses.

Table 7--Expected economic effects of avocado imports from Mexico, longrun model with free trade

	Domestic price	Domestic output	Domestic consumption	Import values	Consumer surplus		Producer surplus			Net welfare gain
					Total	Gain	Total	Transfer to consumer	Infestation loss	
	$/short ton	*--1,000 short tons --*			*Million dollars*					
Autarchy	1,385	132.34	132.34		134.38		91.64			
Free trade (no risk)	878	83.90	222.72	121.88	221.93	87.55	36.83	55.19	0	32.36
Free trade (no risk)										
NM(π_{NM}=1)		41.95		158.72			18.42		18.42	13.94
Nm(π_{Nm}=.05)		79.91		125.39			35.08		1.75	30.60
AM(π_{AM}=.00345)		83.62		122.14			36.71		0.13	32.23
Am(π_{Am}=1.35E-06)		83.90		121.88			36.83		0.05	32.36

Table 8--Expected economic effects of avocado imports from Mexico, longrun model with limited trade

	Domestic price*	Domestic output	Domestic consumption	Import values	Consumer surplus			Producer surplus			Net welfare gain[1]
					Total	Gain	Loss	Total	Gain	Loss	
	$/short ton	*--1,000 short tons --*			*Million dollars*						
Autarchy	1,385	132.34	132.34		134.38		91.64				
Limited trade											
(no risk)	1,368	130.73	137.15	5.64	139.10	4.72		89.41		2.22	2.49
Limited trade (no risk)											
NM(π_{NM}=1)	1,795	85.75	92.18		93.35	2.53	43.55	76.95	31.13	45.82	-55.72
Nm(π_{Nm}=.05)	1,396	127.07	133.50		135.46	2.53	1.45	88.71	1.43	4.36	-1.85
AM(π_{AM}=.00345)	1,370	130.46	136.89		138.84	4.46		89.36		2.27	2.18
Am(π_{Am}=1.35E-06)	1,368	130.72	137.15		139.10	4.72		89.41		2.22	2.49

* Average national domestic price (excluding the northeastern winter regional market, when limited trade occurs).

[1] - implies loss.

free-trade level for imports from Mexico, inducing greater consumption than at past domestic prices. An aggregate price for the rest of the U.S. market was determined by an equilibrium of domestic supply and demand with the northeastern regional demand excluded.

Tables 7 and 8 present some alternative estimates of the economic effects of lifting the avocado ban using a longrun model with elastic supply and demand. The initial equilibrium with avocado imports prohibited occurs at a domestic price of $1,385 per ton and output of 132,340 tons. Consumer surplus is $134.4 million and producer surplus is $91.6 million. When trade is completely liberalized and no pest infestation occurs, the domestic price falls to $878, consumption increases 68 percent (to 222,722 tons), and domestic production declines 47 percent (to 83,904 tons) (table 7). Consumer surplus rises by $87.5 million, producer surplus falls by $55.2 million, and the net welfare gain is $32.3 million (14 percent of initial consumer plus producer surplus). Consumers benefit, but free trade resulting in decreased domestic output has a devastating effect on the domestic industry because it eliminates higher domestic prices sustained by the import ban.

A pest infestation associated with imports would have a further negative effect on domestic avocado producers, and would reduce the net welfare gain from free trade. In the worst case scenario of certain infestation and highest costs, producer surplus falls by an additional $18.4 million in the longrun model. A net welfare gain remains even in this case, although it is reduced to $13.9 million. Thus, in this example, even when a pest infestation occurs with certainty and causes maximal damage (so free trade is bad phytosanitary policy), trade raises net national welfare. For probabilities of pest infestation at Nyrop's minimum or lower, the effect of an infestation on expected producer surplus (taking the probability of an infestation into account) is less than $2 million, and the expected net welfare gain remains above $30 million.

The partial easing of the import ban, which opens the market in the northeastern United States to imports for 3 winter months, has smaller economic effects than free trade when no pest infestation occurs (table 8). The domestic price (for the aggregate market excluding northeastern winter regional demand) falls by 1.2 percent (from $1,385 to $1,368), as domestic consumption displaced from the northeastern winter market is absorbed by a combination of expanded consumption elsewhere and reduced domestic supply. Consumer surplus increases by $2.2 million outside of the northeast (not shown separately in the table) and producer surplus falls by a similar amount (the net welfare gain is only $33,337 outside of the northeastern winter market). In the northeastern region, winter consumption increases and consumer surplus rises by $2.5 million as the price falls to that of imports from Mexico. The net national welfare gain is $2.5 million (about 1 percent of initial total consumer plus producer surplus). Thus, the limited opening of trade under the 1997 partial easing of the import ban has positive effects on northeastern winter consumer surplus, limited positive effects on other consumers and net welfare, and slightly lowers domestic output and the profits of domestic producers.

A pest infestation associated with imports substantially affects the domestic market when only limited trade is allowed under partial easing of the import ban. In the worst case, increased marginal costs and lowered yields reduce producer surplus by $45.8 million, far exceeding the price effect of limited trade without pest infestation. The reduced total supply also pushes the equilibrium domestic price (excluding the northeastern winter regional market) up from $1,385 to $1,795 in the longrun model. The increased price offsets $31.1 million of the loss of producer surplus, leaving a net producer surplus loss of $14.7 million, still almost seven times as large as the loss from limited trade alone.

An economic effect of the pest infestation also affects consumers outside of the northeastern winter market. With the increased domestic price caused by pest damage, consumer surplus falls by $43.5 million. Thus, most of the economic effect of pest risk is borne by consumers outside the northeastern winter market, not by producers, when trade is opened only to the limited extent adopted in 1997.