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Market and Welfare Impacts of COOL on the U.S.-Mexican Tomato Trade

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A two-country, comparative static partial equilibrium model is used to simulate the ex ante market and welfare outcomes of U.S. country-of-origin labeling for the U.S.-Mexico fresh tomato trade. In all scenarios where consumers show a relative preference for U.S. tomatoes, Mexican tomato exports decline and U.S. production increases. Mexican trade losses using low- to mid-range consumer preference assumptions are 14% to 32% of the value of Mexican tomato exports to the United States and 1% to 3% of the total value of agricultural produce exports, partially negating the market access gains of NAFTA. Consumer effects are small and sometimes negative. Producer impact is the big effect, with transfer from Mexican to U.S. tomato producers.

Key Words: country-of-origin labeling, food labeling, trade-related food regulations, welfare effects

Introduction

Information on a product's country of origin influences consumer behavior in a complex manner. Researchers do not agree on the magnitude of the "country-of-origin" effect, but there is general agreement that it differs by product (Verlegh and Steenkamp, 1999) and country (Ehmke, 2006). Since the early 1990s, countries are increasingly requiring retail outlets to identify country of origin by labeling a large variety of agricultural commodities and food products (Josling, Roberts, and Orden, 2004). In the United States, the 2002 and 2008 Farm Bills amended the Agricultural Marketing Act of 1946 to require retailers to notify consumers of the country of origin for beef, lamb, pork, fish, poultry, goat, perishable agricultural commodities, macadamia nuts, pecans, peanuts, and ginseng. The country-of-origin labeling (COOL) requirement was implemented for seafood in 2005, and for other covered products in 2009.

The magnitude of the benefits and costs of COOL implementation, and their incidence, are contentious. The U.S. regulation states: "The intent of this law is to provide consumers with additional information on which to base their purchasing decisions" [U.S. Department of Agriculture/Agricultural Marketing Service (USDA/AMS), 2003, p. 61945]. Proponents argue that society values information that allows consumers to make purchase decisions regarding the origin of their food, regardless of the underlying motivation behind these choices. Congress characterizes the labeling regime as a marketing tool for farmers and ranchers across the nation.[1] Opponents assert that costs to industry greatly outweigh any benefits and

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[1] This statement is found in a September 25, 2008, letter from Senator Tom Harkin (D-Iowa) and 30 other senators to Secretary of Agriculture Edward Schafer.

may eventually lead to retailers removing products from supermarket shelves, inadvertently reducing consumer options (Carter and Zwane, 2003; USDA/AMS, 2003). Internationally, trade partners describe COOL as protectionist and argue that the regulation is noncompliant with U.S. commitments under the Uruguay Round Agreement and North American Free Trade Agreement (NAFTA) (U.S. General Accounting Office, 1999).

We use a two-country, comparative static partial equilibrium model to assess the ex ante market and welfare outcomes of the U.S. COOL regime on U.S.-Mexico tomato trade. Fresh tomatoes from Mexico have been the number one horticultural import product to the United States since the early 1990s (Grant, Lambert, and Foster, 2010), and U.S.-Mexico tomato trade has historically been the subject of a series of trade disputes (Bredahl, Schmitz, and Hillman, 1997). Only a few studies have estimated the effects of COOL on U.S. trade and its trading partners (Peel, 2003; Rude, Javis, and Brewin, 2006). In contrast with much of the existing literature on COOL, our analysis addresses consumer information benefits as well as Mexican and U.S. producer costs in order to evaluate the overall economic impact of the regulation.

Overview of U.S.-Mexican Tomato Trade

Imports of Mexican fresh tomatoes to the United States have been a source of contention since the prohibition of tomato imports from Cuba in the early 1960s. As a result of the discontinuation of the Cuban supply, both the Florida and Northwest Mexican (Sinaloa) growers rapidly boosted production in order to expand their winter seasonal market shares (Thompson and Wilson, 1997). The first significant U.S.-Mexico tomato trade conflict surfaced during the 1968–69 marketing years when the Florida Marketing Trade Committee proposed legislation to set larger size requirements for vine-ripe tomatoes than mature green tomatoes. This legislation reduced the supply of largely Mexican-produced vine-ripe tomatoes, increasing demand for the primarily Florida-produced mature green tomatoes. A court order initiated by Arizona-based importers in 1975 eventually overturned this legislation (Thompson and Wilson, 1997; Bredahl, Schmitz, and Hillman, 1997).

Following the court injunction, Florida producer groups lobbied for mandatory retail-level country-of-origin labeling on fresh tomatoes and import price triggers to support domestic tomato prices year-round. After these initial attempts failed, and despite Mexico's establishment of voluntary export quotas, a coalition of Florida producer groups initiated an anti-dumping complaint with the Department of Commerce in 1978, claiming Mexico was selling produce at below the fair market value during the winter months. During the period of the anti-dumping dispute, Florida producer groups were able to garner support for a state-level mandatory country-of-origin labeling program for fresh produce that became effective in 1979. A 1984 ruling determined that Mexican producers were not dumping produce in the United States (Thompson and Wilson, 1997; Bredahl, Schmitz, and Hillman, 1997).

In the early 1990s, NAFTA and the Uruguay Round Agreement on Agriculture (URAA) appeared to signal a breakthrough for Mexican producers trying to gain increased access to the U.S. domestic market. Under NAFTA, the United States gradually phased out its summer seasonal tariffs for fresh Mexican tomatoes over a four-year period ending in 1998, and through the use of a tariff rate quota also gradually reduced winter month tariff measures over a nine-year period ending in 2003. Under the URAA, U.S. tariffs on all imported tomatoes were also phased out by 2000.

However, tomato trade disputes began to resurface between the two countries in 1996, when the Florida tomato industry accused Mexico of selling tomatoes at below fair market value prices, and the U.S. Department of Commerce again initiated an anti-dumping investigation against Mexico. The investigation was suspended later in 1996, and Mexican producers agreed to a reference price floor. The suspension agreement was revisited in 2002, setting separate floor prices for the summer and winter seasons. The voluntary export restraint agreement was again signed in 2008 (USDA/AMS, 2008).

Between 1993, when NAFTA took effect, and 2000, Mexican tomato imports grew by 47% [USDA/Economic Research Service (ERS), 2002].[2] Imports accounted for one-third of U.S. tomato consumption in 2003, with Mexico making up 81% of this trade (USDA/ERS, 2004). Mexican imports continued to increase through 2007, despite the anti-dumping suspension agreement; during the post-NAFTA period (1993 to 2007), fresh tomatoes averaged 11% of the value of Mexican agricultural exports to the United States (U.S. Department of Commerce, 2008).

Thompson and Wilson (1997) found that grower-shipper arrangements dominate the early stages of the production supply chain in the North American fresh tomato market. Grower-shipper firms in California, Florida, Sinaloa (Northwest Mexico), and Mexico's Baja California vie for market share during different times of the year. Florida and Sinaloa producers supply the U.S. market with tomatoes during the late fall, winter, and spring seasons, while California, Mexico's Baja California, and U.S. regional producers compete for demand during the late spring and summer months. Grower-shippers are increasingly extending their market season by purchasing or leasing land or contracting with local producers in regions with a different growing season. Some of these vertically integrated companies have production occurring in both the United States and Mexico.

A Model of Quality Differentiation by Country of Origin

A growing number of researchers have adapted Mussa and Rosen's (1978) vertical product differentiation framework to evaluate the market and welfare effects of a label supplying information about a credence quality attribute to consumers. Examples include hormone-treated beef (Bureau, Marette, and Schiavina, 1998), eco-labels (Nimon and Beghin, 1999), genetically modified crops (Fulton and Giannakas, 2004; Giannakas and Fulton, 2001), and indications of source (Zago and Pick, 2004; Awada and Yiannaka, 2006; Plastina, 2007). The analytical framework and empirical work conducted in this paper draw upon this well-developed thread of earlier research.

The model utilizes linear supply and demand function intercepts and slopes to estimate changes in market and welfare equilibria resulting from COOL. It differs from other frameworks used to estimate the market and welfare impacts of COOL (see, for example, work using equilibrium displacement models by Lusk and Anderson, 2004; Brester, Marsh, and Atwood, 2004; and Chung, Zhang, and Peel, 2004) in that it derives post-COOL differentiated demand curves from a single pre-COOL nonlabeled demand function. This feature of the framework is closely linked to the intent of our research, which focuses on estimating the impact of consumer perception regarding the origin quality of tomatoes on trade with Mexico.

[2] This same USDA/ERS (2002) analysis predicted that NAFTA tariff changes led to an 8% to 15% increase in imports over what would have occurred from URAA commitments. The increase in export volumes was not just a result of reduced tariffs; additional factors were Mexican peso devaluation, new seed varieties lengthening the shelf life of tomatoes, and increased tomato consumption in the United States.

Supply and demand parameters representing the pre- and post-COOL states of the regulation are denoted by the subscripts n (nonlabeled pre-COOL) and l (labeled post-COOL). Subscripts u and m represent the U.S. and Mexican markets, respectively.

Pre- and Post-COOL Consumer Demand

In the pre-COOL scenario, consumers cannot distinguish between the two types of tomatoes because they do not have any origin information. In the post-COOL environment, a label allows consumers to purchase according to their individual preferences for the two qualities (yielding differentiated demand curves). The pre- and post-COOL inverse demand functions describe prices (p) as a function of quantities (q). The parameter μ^0 is an intercept, the slope is negative, and the parameter μ^1 is the absolute value of the slope:

$$(1) \qquad p_j(q_j) = \mu_j^0 - \mu_j^1 q_j,$$

where j is either n (nonlabeled), lm (Mexican), or lu (United States).

In the pre-COOL setting, we assume the slope parameter for nonlabeled tomatoes is a weighted average of the corresponding slope parameters describing consumer preferences for labeled U.S. and Mexican tomatoes. The weights are the quantity shares of U.S. and Mexican tomatoes on the market in the unlabeled state.[3] The model assumes the parameter μ_{lm}^1 is largest, because the price must be lowered most steeply to convince consumers to purchase an additional marginal unit of Mexican tomatoes. Hence, $\mu_{lm}^1 > \mu_n^1 > \mu_{lu}^1$.

A structural model of utility maximization put forward by Giannakas and Fulton (2001) and Plastina (2007) is useful for stating the relationships among the demand function parameters more precisely. Suppose consumers vary in the utility they gain from consumption of Mexican and U.S. tomatoes or from consumption of a nonlabeled tomato that consumers treat as a weighted mixture of Mexican and U.S. tomatoes. The net utility takes the following form:

$$(2) \qquad U_j = U - \mu_j^1 c - p_j,$$

where j is either n, lm, or lu. The constant U is a base level of utility with no tomato purchase. The characteristic c reflects heterogeneous consumer preferences for the origin quality of tomatoes, where c is uniformly distributed from 0 to C in the population. U.S. consumers with a low c value have a weak preference for domestic products, and those with a high c value have a strong preference for domestic products.

In the unlabeled pre-COOL scenario, a consumer making a marginal expenditure must choose between two options: purchasing a nonlabeled tomato or purchasing something else. For a consumer who does purchase a tomato, equation (2) shows that U_j falls as p_j rises, because the tomato is more expensive. The option of purchasing something else offers utility denoted $U - \mu_n^0$. One may think of the parameter μ_n^0 as the price above which no consumer will choose tomatoes.[4] The consumer chooses whichever option offers the highest utility.

[3] Specifically, the model assumes that both post-COOL inverse demand slopes are a function of the pre-COOL inverse demand slope μ_n^1, the quantity shares of Mexican and U.S. tomatoes in the market, and the relative degree of preference for U.S. tomatoes $[(\mu_{lm}^1 - \mu_{lu}^1)/\mu_{lu}^1]$ (Plastina, 2007).

[4] Giannakas and Fulton (2001) and Plastina (2007) describe this parameter as the price of a substitute product.

Figure 1 shows pre-COOL consumer utility as a function of c. For each value of c, either tomato purchase or nonpurchase offers the highest utility. For a consumer with $c = 0$, indicating the greatest utility from purchasing a tomato, the vertical intercept is derived from equation (2): $U - p_n$. Because c is uniformly distributed, one can derive the fraction of the population that prefers each of the two options. At a threshold value of c^*, a marginal consumer obtains equal utility from purchasing a nonlabeled tomato or something other than a tomato: $U - \mu_n^1 c^* - p_n = U - \mu_n^0$. This equality can be used to solve for $p_n = \mu_n^0 - \mu_n^1 c^*$. The demand for nonlabeled tomatoes q_n equals the fraction of the population that chooses to purchase a tomato, which equals c^* (see figure 1). Hence, the inverse demand curve is given by:

$$(3) \qquad p_n = \mu_n^0 - \mu_n^1 q_n ,$$

which corresponds to equation (1).

The pre-COOL consumer surplus measure equals the area under the unlabeled tomato utility curve and the "substitute product" utility curve (which corresponds to the area under the bold dashed line in figure 1):

$$(4) \qquad CS = \left[(\mu_n^0 - p_n)^2\right] / \, 2\mu_n^1 + \text{ shaded area}.$$

Appendix B provides pre- and post-COOL market equilibria calculations.

Figure 2, by contrast, shows the post-COOL utility function as a function of c. Consumers now have three options: purchasing a Mexican tomato, purchasing a U.S. tomato, or purchasing something else. Each consumer (with a unique value of c) will choose the option that generates the highest utility. Recall that consumers with low values of c have the weakest preference for the U.S. product. Consumers with characteristic $c \in [0, c^{**}]$ purchase Mexican tomatoes, while consumers with characteristic $c \in [c^{**}, c^{***}]$ purchase U.S. tomatoes. By identifying the consumer who derives the same utility from purchasing either a Mexican or U.S. tomato (c^{**}: $U_{lm} = U_{lu}$) and solving for c, one can obtain the taste parameter (c^{**}) for the marginal consumer, and the quantity demanded of Mexican tomatoes:

$$(5) \qquad q_{lm} = c^{**} = (p_{lu} - p_{lm}) \, / \, (\mu_{lm}^1 - \mu_{lu}^1) \, .$$

Similarly, by identifying the consumer who derives the same utility from either purchasing a domestic tomato or something other than a tomato (c^{***}: $U_{lu} = U - \mu_n^0$), the quantity demanded of U.S. tomatoes can be obtained:

$$(6) \qquad q_{lu} = c^{***} - c^{**} = \left[(\mu_n^0 - p_{lu})/\mu_{lu}^1\right] - \left[(p_{lu} - p_{lm})/(\mu_{lm}^1 - \mu_{lu}^1)\right].$$

Through substitution, the differentiated inverse demand functions for Mexican and U.S. tomatoes, which correspond to equation (1), can be derived as:

$$(7) \qquad p_{lm} = \left[\mu_n^0 - \mu_{lu}^1 q_{lu}\right] - \mu_{lm}^1 q_{lm}$$

and

$$(8) \qquad p_{lu} = \left[\mu_n^0 - \mu_{lu}^1 q_{lm}\right] - \mu_{lu}^1 q_{lu} \, .$$

The intercepts in square brackets in equations (7) and (8) show that Mexican and U.S. tomatoes are substitutes and that the demand for labeled Mexican tomatoes falls as the equilibrium quantity of U.S. tomatoes increases, and vice versa. The post-COOL U.S. consumer

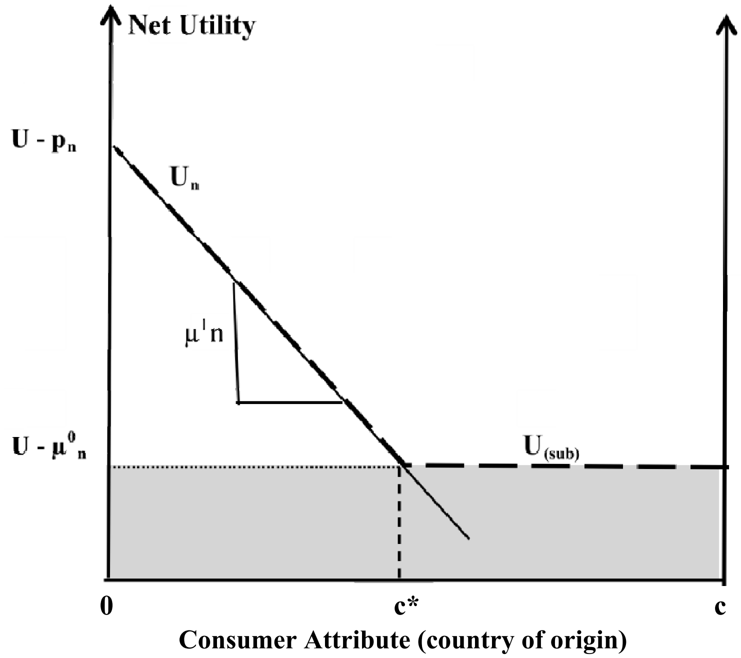

Figure 1. Pre-COOL consumer utility and related welfare

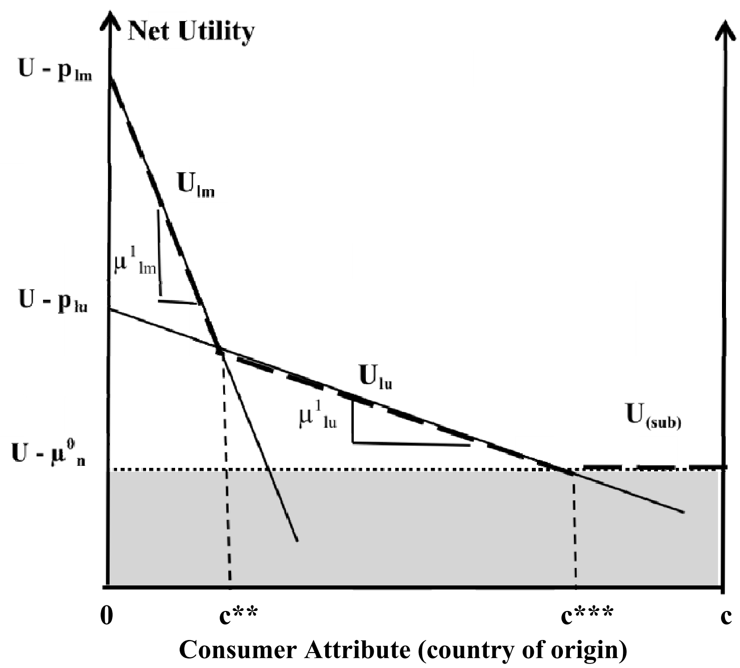

Figure 2. Post-COOL consumer utility and related welfare

surplus measure for consumption of U.S. and Mexican tomatoes equals the area under the utility functions in figure 2 (the area under the bold dashed line):

$$(9) \qquad CS = \left[(p_{lu} - p_{lm})^2\right] / \left[2(\mu_{lm}^1 - \mu_{lu}^1)\right] + \left[(\mu_n^0 - p_{lu})^2\right] / 2\mu_{lu}^1 + \text{shaded area}.$$

Pre- and Post-COOL Supply

In both the pre- and post-COOL scenarios, U.S. retailers purchase tomatoes from U.S. and Mexican producers, such that some combination of both domestic and Mexican tomatoes make up the retail supply available to consumers. The supply-side analytical framework distinguishes between the producer and the retailer in order to adequately attribute the costs of record keeping, segregation, and labeling to the correct participants within the supply chain. The producer analysis includes growers and shippers, while the intermediaries (handlers, importers, processors, and wholesalers) are included in the retailer analysis.

As part of ensuring origin information throughout the supply chain, the COOL regulation requires that any establishment (grower, shipper, re-packer, importer, distributor, or wholesaler) supplying tomatoes to a retailer, either directly or indirectly, must provide country-of-origin information for the tomato to the subsequent purchaser of the product. In practice, U.S. tomato growers and importers of Mexican tomatoes already keep records that can be used to substantiate origin claims. However, this information is not systematically transferred to the subsequent purchaser. Therefore, producers and importers will incur costs as a result of COOL. Mexican growers are already required to provide origin information as part of standard Customs and Border Patrol marking regulations and will not face increased per unit costs of production.

Tomato re-packers and distributors are expected to bear a significant portion of the costs associated with implementing COOL legislation as they will be required to attain producer origin records, maintain identity of the tomato throughout the handling stages, and pass on this information through records or by pre-labeling or packaging the product. The retailer must also maintain origin records and provide country-of-origin information either by individually labeling a tomato or using a bulk container (i.e., display case, carton, shipper bin, etc.) to relay country of origin to the consumer (USDA/AMS, 2008, p. 45113).

Equation (10) represents the pre-COOL linear inverse supply functions at the retail level:

$$(10) \qquad p_n = \delta_j^0 + \delta_j^1 q_j ,$$

where j is either nm, nu, or num (combined retail). Figure 3 illustrates price and quantity determination in the market for unlabeled tomatoes before the implementation of COOL. The retail-level inverse supply function for all producers (S_{num}) is the horizontal sum of the separate inverse supply functions for Mexican producers (S_m) and U.S. producers (S_{us}). Because the tomatoes are unlabeled, the intersection of the supply and demand functions for all tomatoes determines the equilibrium market price (p_{nl}) and quantity (q_{num}). Once p_{nl} is determined, the intersection of p_{nl} with the separate U.S. and Mexican supply functions determines, respectively, the U.S. supply quantity (q_{nu}) and the Mexican supply quantity (q_{nm}).

Producer-level inverse supply curves (not shown) mirror those of the retail level except the intercepts are shifted downward to reflect a per unit marketing margin. In practice, the slope

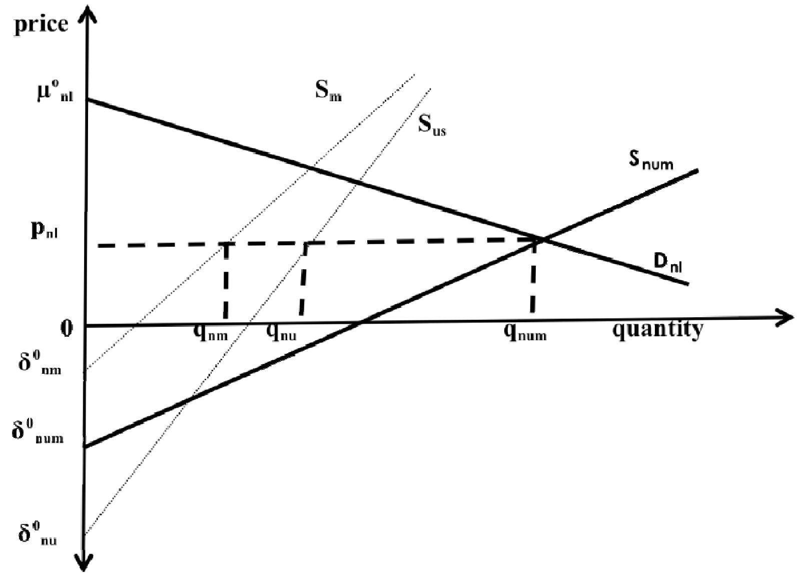

Figure 3. Pre-COOL market and welfare outcomes

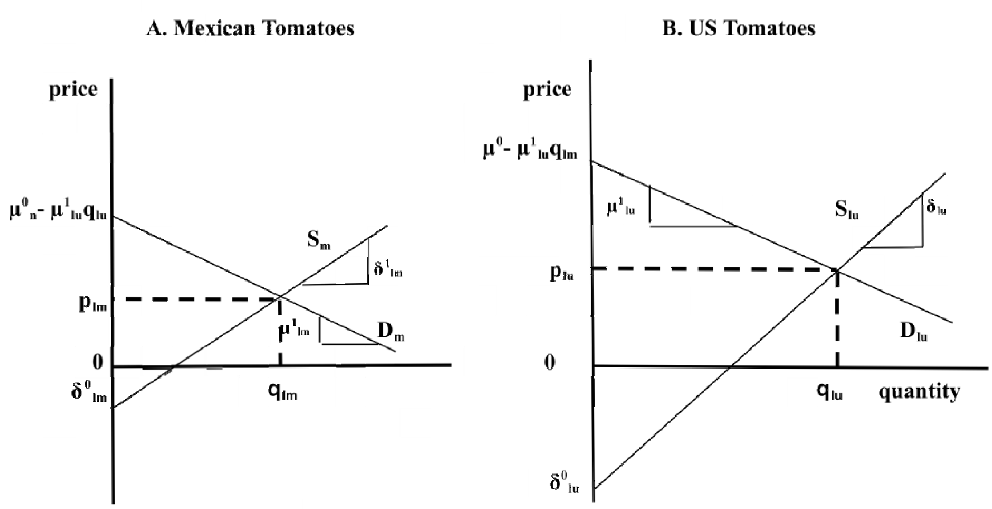

Figure 4. Post-COOL market and welfare outcomes

parameter δ_j^1 can be derived from empirical estimates of the producers' supply elasticity. For an equilibrium quantity and price, equation (10) can be solved for the intercept (δ_j^0).[5]

By contrast, figure 4 illustrates price and quantity determination in the post-COOL market for labeled tomatoes. Because the inverse demand functions now separately represent consumer demand for Mexican and U.S. labeled tomatoes, figure 4 is split into two panels corresponding to the two sources of tomatoes. The Mexican and U.S. inverse supply functions are the same as in figure 3, except that they have been shifted upward to account for implementation costs. The intersections of supply and demand for Mexican tomatoes in the left panel and U.S. tomatoes in the right panel determine the equilibrium prices (p_{lm} and p_{lu}) and quantities (q_{lm} and q_{lu}). Although the two panels appear separate, close inspection of the intercepts of the demand functions shows how they are linked. If the quantity of U.S. tomatoes (q_{lu}) increases, then demand for Mexican tomatoes is suppressed, and vice versa. The determination of prices and quantities by solving equations (7), (8), and (10) involves both markets simultaneously.

The post-COOL intercept of the U.S. inverse supply function, δ_{lu}^0, equals δ_{nu}^0 plus the additional grower-level record-keeping costs, and intermediary- and retail-level labeling and market segregation costs. The intercept of the Mexican post-COOL supply function, δ_{lm}^0, only adds the additional unit costs incurred at the intermediary and retail levels to δ_{nm}^0.

In both the pre- and post-COOL environments, the producer surplus is the area above the inverse supply function and below the equilibrium price (see figures 3 and 4). In the pre-COOL state:

$$PS_j = (1/2)(p_n - \delta_j^0)q_j, \tag{11}$$

where j is either nm or nu. Because the intercepts of our supply functions are negative, as described above, we adjust the producer surplus from equation (11) by subtracting the region of consumer surplus corresponding to negative prices.

In the post-COOL state, similar equations are used for producer surplus in Mexico and the United States, except that the post-COOL equilibrium prices are different for U.S. and Mexican tomatoes, and the supply intercepts are adjusted upward for the additional costs of COOL.

Ex Ante Market and Welfare Outcomes of U.S. COOL

We simulated the change in market and welfare outcomes for U.S.-Mexican tomato trade due to COOL implementation.[6] For robustness, the simulations used multiple values for key parameters: (*a*) relative preference for U.S. tomatoes, (*b*) labeling and record-keeping costs, (*c*) elasticity of demand, and (*d*) elasticity of supply. (Appendix A provides a description of the data used for calibrating the simulation model.)

Relative Preference for U.S. Tomatoes

We used four levels of consumer preference for U.S. tomatoes $[(\mu_m^1 - \mu_{us}^1)/\mu_{us}^1]$: high, medium, low, and no preference. The high preference value of 60% is based on Mabiso et al. (2005),

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[5] With empirical short-run supply elasticity estimates, this intercept is negative. It has no literal interpretation as a reservation price. Instead, the inverse supply function is considered a linear approximation that is tolerably accurate in the neighborhood of the equilibrium.

[6] For the purposes of this study, fresh tomatoes include round, roma (plum), greenhouse (hothouse), cherry tomatoes, and small quantities of other varieties.

who found that consumers on average are willing to pay a 93 cent per pound (60%) premium for tomatoes labeled "USA grown" when they know that the nonlabeled alternative is Mexican tomatoes.[7] The no preference value of 0% reflects the USDA/AMS assumption of no preference, and therefore no benefit to consumers. Because hypothetical willingness-to-pay studies are sometimes thought to overstate real-world price differentials, we prefer medium preference (30%) and low preference (10%) as intermediate values.

Labeling and Record-Keeping Costs

We used two cost estimates. At the grower level, the low cost estimate comes from the USDA/AMS (2003) low range estimate ($10 per ton) for U.S. grower record-keeping costs. The high cost estimate is based on the Sparks Companies, Inc. (2003) calculation of $70/ton. Although this amount exceeded the 2003 USDA/AMS high range estimate, we used it in order to test a full range of possible cost outcomes. At the intermediary/retailer level, the *low cost* ($9.70 per ton) and *high cost* ($40 per ton) estimates are taken from USDA/AMS. Our empirical estimates include multiple scenarios with both *high cost* and *low cost* estimates, but, for conciseness, our most detailed estimates of quantity changes focus on the *high cost* estimates.

Elasticity of Demand

The *low* estimate for own-price elasticity of demand ($\eta = -0.32$) is based on analysis that used U.S. retail fresh tomato data from the period 1981–2004 (Russo, Green, and Howitt, 2008). The *high* estimate ($\eta = -1.15$) is based on 1999 retail data from six U.S. urban locations (Thompson, 2003). Because of our prior expectation that short-run demand elasticities would be inelastic, our preferred estimates are the *low* estimates.

Elasticity of Supply

The *low* short-run price elasticity of U.S. and Mexican tomato supply comes from a study that calculated elasticities of supply using data from 1974–1993 ($\varepsilon_{us} = 0.07$, $\varepsilon_m = 0.19$) (Malaga, Williams, and Fuller, 2000). The *high* price elasticity of U.S. tomato supply ($\varepsilon_{us} = 0.27$) comes from a paper calculating the short-run elasticity of supply for California fresh tomatoes using data from 1987–2002 (Russo, Green, and Howitt, 2008). Unfortunately, the latter paper had no corresponding estimates for Mexican supply. Hence, our *high* price elasticity of Mexican tomato supply ($\varepsilon_m = 0.40$) assumed an increase over the *low* estimate that is similar to the relationship in the findings reported by Malaga, Williams, and Fuller (2000). We prefer the *high* price elasticity of supply estimates because they are based on relatively more current data.

In our results section, we present outcomes for the *medium* and *low* consumer preference scenarios in table format and then discuss these results in the text. For the *high* and *no* preference scenarios, the results are only briefly described in the text. Under the *medium* and *low* preference assumptions, we report results for both *high* and *low* assumptions about costs, demand elasticities, and supply elasticities. However, for tractability, we do not include all

[7] In contrast, the same study revealed that U.S. consumers were willing to pay a $US 0.38/lb. premium for "USA grown" tomatoes over Canadian tomatoes (Mabiso et al., 2005).

possible combinations of these parameter assumptions, which would require reporting 32 sets of results. Instead, we present a greater number of scenarios with the preferred *low* demand elasticity scenarios and *high* supply elasticity scenarios.

Results and Discussion

Table 1 shows simulation results for the change in market and welfare outcomes for the U.S.-Mexican tomato trade due to COOL implementation. The first four columns of results assume a *medium* preference for U.S. tomatoes and the last four columns assume a *low* preference for U.S. tomatoes. The *high* preference results (not shown) mirror those for *medium* preference outcomes, except they are approximately 1.5 to 2 times higher in magnitude. The results of the *no* preference scenario (not shown) are similar to those for low preference, with somewhat smaller magnitudes. The total welfare effect (i.e., Mexican producer welfare plus U.S. total producer and consumer welfare combined) is negative in all *no* preference results, because in these scenarios COOL imposes additional costs without providing any consumer benefits.

Under the four *medium* preference scenarios, Mexican producers fare poorly and U.S. producers fare well. COOL would lead to a 4% to 16% decrease in Mexican exports to the United States, a lower Mexican tomato equilibrium retail price, and a lower farm-gate price paid to Mexican grower-shippers. The welfare losses for Mexican tomato supply chain participants are 7% to 28%. The Mexican tomato share in the U.S. market declines by 6% to 20%. COOL would lead to a higher U.S. tomato quantity sold, retail price, and farm-gate price. The U.S. share of the tomato market would grow by 3% to 10%. The increase in producer welfare for U.S. supply chain participants ranges from 12% to 32%, with the high outcomes associated with scenarios of inelastic demand and relatively more elastic Mexican and U.S. supply. The U.S. consumer welfare increases much less, and, in two scenarios, actually decreases. Thus, the predominant welfare effects under the *medium* preference scenarios are a transfer of welfare from Mexican to U.S. producers and, in some cases, from U.S. consumers to U.S. producers.

Under the four *low* preference scenarios, all quantity, price, and welfare changes are much smaller. The total quantity of tomatoes consumed increases by 1% or less. Still, under all scenarios, Mexican producers suffer a change in welfare from −3% to −13%, while U.S. producer welfare increases by 4% to 12%. Change in U.S. consumer welfare is negative by less than 1% under all scenarios except when cost estimates are low, demand is inelastic, and supply estimates are elastic, in which case U.S. consumer welfare increases by less than 1%. Under all *low* preference scenarios, COOL leads to small increases in U.S. total welfare (producers and consumers combined) and in total welfare of 1% to 2%. Again, the welfare results are dominated by a shift of producer welfare from Mexican to U.S. growers.

In summary, the simulation reveals that the quantity of Mexican tomato exports declines and the quantity of U.S. tomatoes increases in all scenarios in which consumers show a relative preference for U.S. over Mexican tomatoes. Under these same assumptions, Mexican producer welfare decreases while U.S. producer welfare increases. Change in consumer welfare varies across scenarios. COOL leads to positive total welfare effects when consumers have a *medium* preference or *high* preference for the U.S. version of the product.

The primary stated objective of U.S. COOL legislation is to provide valuable information to consumers so they may purchase products in line with their preferences. If changes in U.S. consumer welfare as defined here provide a measure of the net impact of mandating COOL

Table 1. Market and Welfare Effects of COOL on U.S.-Mexican Tomato Trade

Description	***MEDIUM* Relative Preference for U.S. Tomatoes**				***LOW* Relative Preference for U.S. Tomatoes**			
U.S. Grower Record-Keeping Costs (R = \$0.10/ton, \$0.70/ton)	High	Low	Low	Low	High	Low	Low	Low
Intermediary/Retailer Labeling Costs (L = \$9.70/ton, \$40.00/ton)	High	Low	Low	Low	High	Low	Low	Low
Price Elasticity of Demand ($\eta = -0.32, -1.15$)	Low	High	Low	Low	Low	High	Low	Low
Price Elasticity of Supply (U.S.) ($\varepsilon = 0.07, 0.27$)	High	High	High	Low	High	High	High	Low
Price Elasticity of Supply (Mexico) ($\varepsilon = 0.19, 0.40$)	High	High	High	Low	High	High	High	Low
	Percentage Change							
U.S. Quantity	14.5	5.7	14.8	5.7	5.2	1.9	5.4	2.0
Mexican Quantity	−16.3	−3.5	−15.5	−4.4	−7.6	−1.6	−6.7	−1.9
Total Quantity	4.4	2.6	4.8	2.4	1.0	0.7	1.4	0.7
U.S. Retail Price	15.7	5.7	14.5	21.4	7.1	2.2	5.7	7.7
Mexican Retail Price	−7.8	−1.8	−9.3	−5.5	−2.2	−0.6	−3.6	−2.1
U.S. Farm-Gate Price	56.5	21.2	55.4	82.3	22.6	7.2	20.9	29.0
Mexican Farm-Gate Price	−35.6	−8.3	−37.5	−22.9	−13.4	−3.5	−15.4	−9.2
Mexican Market Share	−19.8	−6.0	−19.4	−6.7	−8.5	−2.3	−8.0	−2.6
U.S. Market Share	9.7	3.0	9.5	3.3	4.2	1.1	4.0	1.3
U.S. Consumer Welfare	1.2	−1.4	2.1	−1.9	−0.4	−0.7	0.5	−0.7
U.S. Producer Welfare	32.0	11.7	32.0	25.3	11.6	3.9	11.4	8.9
U.S. Total Welfare (Producer & Consumer)	6.4	4.2	7.1	5.5	1.6	1.2	2.3	1.9
Mexican Producer Welfare	−28.2	−6.7	−28.2	−9.1	−12.6	−3.0	−12.5	−3.7
Total Welfare	4.6	2.8	5.2	4.2	0.9	0.7	1.6	1.4

on consumers, then the ex ante simulation results suggest the consumer welfare effect is only positive in two out of four cases for *high* and *medium* preferences for U.S. over Mexican tomatoes, is negative in three out of four cases for *low* preferences, and negative in all cases where there is *no* preference. In all preference scenarios except *no* preference, the magnitude of percentage increases in U.S. producer welfare and decreases in Mexican producer welfare are several times greater than the magnitude of percentage changes in U.S. consumer welfare.

Table 2 presents data on the actual change in U.S. and Mexican consumer and farm-gate tomato prices, quantities demanded, and the value of production resulting from COOL. These results are based on the middle preference estimates of *medium* and *low*, the high cost assumptions, the low elasticity of demand estimate, and the high Mexican and U.S. elasticity of supply figures. For the Mexican tomato industry, results show that COOL implementation with *low* and *medium* preferences, respectively, would lead to a \$US 105 to 241 million decline in value of exports to the United States. These findings were based on the 50,000 and 106,000 ton decrease in exports occurring in conjunction with a respective \$US 0.05/lb. and \$US 0.14/lb. decrease in export price. The corresponding retail domestic price decrease for Mexican tomatoes was \$US 0.03/lb. under the *low* preference scenario and \$US 0.12/lb. for the *medium* preference value. Based on 2006 agriculture export data, the combined effect of declines in price and exports amounts to between 14% and 32% of the dollar value of Mexican tomatoes

Table 2. Economic Impact of COOL for *Medium* and *Low* Relative Preference for U.S. Tomatoes vs. Mexican Tomatoes

			***MEDIUM* Relative Preference for U.S. vs. Mexican Tomatoes**			***LOW* Relative Preference for U.S. vs. Mexican Tomatoes**		
Indicator	Units	Pre-COOL	Post-COOL	Pre-Post Difference	% Change from Base	Post-COOL	Pre-Post Difference	% Change from Base
Mexican Tomatoes								
Quantity Consumed [a]	ton (1,000s)	653	547	−106	−16.3	603	−50	−7.7
Consumer Price	$US/lb.	1.56	1.44	−0.12	−7.8	1.53	−0.03	−2.1
Export Price	$US/lb.	040	0.26	−0.14	−35.6	0.35	−0.05	−13.4
Value of Exports [b]	$US (1,000s)	522,706	281,705	−241,001	−46.1	417,879	−104,827	−20.1
Market Share	%	33	26	−7	−21.2	30	−3	−9.1
U.S. Tomatoes								
Quantity Consumed [c]	ton (1,000s)	1,327	1,520	194	14.6	1,396	69	5.2
Consumer Price	$US/lb.	1.56	1.81	0.25	15.7	1.67	0.11	7.1
Farm-Gate Price	$US/lb.	0.40	0.63	0.23	56.5	0.49	0.09	22.6
Value of Production [d]	$US (1,000s)	4,147,733	5,409,324	1,351,627	32.6	4,672,412	524,679	12.6
Market Share	%	67	74	7	10.4	72	5	7.5

[a] Quantity consumed is the 2006 quantity of Mexican fresh tomato exports to U.S. adjusted for home consumption. (*Source:* U.S. Department of Commerce/U.S. Census Bureau, Foreign Trade Statistics, 2008.)

[b] Value of exports is derived from the quantity consumed and export price of Mexican tomatoes.

[c] Quantity consumed is the 2006 U.S. fresh tomato production less exports and adjusted for home consumption. (*Source:* USDA/National Agricultural Statistics Service, 2006.)

[d] Value of production is derived from the quantity consumed and consumer price of U.S. tomatoes.

exported to the United States, and 1% to 3% of the dollar value of total agricultural produce exported to the United States.[8]

In contrast, the farm-gate price of U.S. tomatoes increased by $US 0.09/lb. for the low preference scenario and $US 0.23/lb. for the medium preference scenario. Consumption of U.S. tomatoes increased between 69,000 to 194,000 tons in the two scenarios. The combined increase in price and consumption effects ranged between 8% and 21% of the dollar value of U.S. fresh tomato production in 2006.[9] While these findings support claims that COOL will deliver price premiums to U.S. tomato supply chain participants, some researchers question whether these price gains would be maintained in the long run without some form of supply management and ongoing promotion of "U.S." brand produce (Carter, Krissoff, and Zwane, 2006).

Another component of the impact of COOL on U.S. producers is the distribution of benefits within the supply chain. Research studies estimating the distribution of COOL costs and benefits

[8] Statistics are calculated based on the difference in value of Mexican exports resulting from COOL as a percentage of the 2006 total value of fresh tomato exports and the 2006 total value of Mexican agricultural exports to the United States. The total value of 2006 Mexican fresh tomato exports ($US 744,596,530) is calculated by multiplying the total quantity of Mexican exports (unadjusted for home consumption) (930,746 tons) by the pre-COOL farm-gate export price ($US 800/ton) (U.S. Department of Commerce/U.S. Census Bureau, 2008; USDA/National Agricultural Statistics Service, 2006). The value of 2006 Mexican agricultural exports totals $US 9,390,731,000 (U.S. Department of Commerce/U.S. Census Bureau, 2008).

[9] Statistics are calculated based on the difference in value of U.S. fresh tomato production resulting from COOL as a percentage of the 2006 total retail value of fresh tomato production. The total retail value of 2006 U.S. fresh tomato production ($US 6,393,036,000) is calculated by multiplying the total quantity produced (unadjusted for home consumption and exports) (4,098.1 million lbs.) by the pre-COOL retail price ($US 1.56/lb.) (USDA/National Agricultural Statistics Service, 2006).

along the supply chain have not yielded consistent results. Thus it is unclear whether grower-shippers or retailers and processors will be the primary beneficiaries of the expected boost in U.S. tomato demand. Furthermore, many of the U.S. processors and retailers who market and distribute U.S. tomatoes also distribute Mexican tomatoes. A portion of the welfare losses associated with the distribution of Mexican tomatoes (the processor and retailer end of the supply chain) would also be incurred by the U.S. supply chain, reducing their net welfare gains from country-of-origin labeling.

Further development of this model, or use of alternative models (such as equilibrium displacement models) that better attribute benefits and losses to the respective Mexican and U.S. segments of the supply chain, will strengthen impact estimates in the future. Finally, U.S.-Mexico fresh tomato trade is bound by seasonal production constraints. If U.S. tomatoes are not available on the retail shelf during a given time of year, consumers with a preference for domestic tomatoes are forced to make substitution decisions during this time period. To the extent that such seasonal supply constraints exist, the results are likely to overstate the associated market and welfare effects.

Conclusions

Tomato trade between the United States and Mexico has been characterized by trade disputes as far back as the 1970s, and disagreement remains today. The implementation of COOL will likely aggravate these tensions. The simulation results presented here evaluate the economic and welfare impacts of U.S. COOL on the Mexican-U.S. tomato trade, taking into consideration several factors that affect them, including the degree to which U.S. consumers prefer U.S. over Mexican tomatoes, the record-keeping and labeling costs associated with the regulation, and demand and supply price elasticities. Ex ante simulation results employing a low to mid-range consumer preference scenario for U.S. over Mexican tomatoes reveal that COOL has the potential to reduce the dollar value of Mexican tomato exports to the United States by 14% to 32% and total agricultural exports by 1% to 3%.

From the perspective of Mexico, COOL partially negates the hard-fought U.S. tomato tariff reductions achieved under NAFTA and the URAA. Given Mexico's relative endowments and proximity to the United States, gains from NAFTA were expected for its perishable agricultural sector. While Mexican tomato exports have been a trade success story in the post-NAFTA period, the projected impacts of COOL suggest an erosion of the potential gains on which the agreement was predicated.

The results also suggest that changes in consumer welfare as a result of COOL implementation in this market are only sometimes positive at *high*, *medium*, and *low* preferences for U.S. over Mexican tomatoes and often negative, particularly when preferences are low or zero. The magnitude of these changes in consumer welfare is, in any case, relatively small compared to the magnitude of increases in U.S. and decreases in Mexican producer welfare.

Additionally, these simulation findings highlight a tension between food-related consumer information policies that may enhance domestic (consumer and producer) welfare, while simultaneously causing deleterious economic effects on producers in countries that are close trading partners. Such scenarios have important implications for domestic-level regulatory decision-making structures currently used to evaluate these regulations. Estimates of the benefits of providing consumers with information have not been systematically incorporated into formal regulatory impact analysis by U.S. agencies for labeling policies.[10] The standard economic approach to valuation of information provision would be to ascertain the amount consumers are willing to pay for products with the labeling information. However, the USDA/AMS Regulatory Impact Analysis conducted as part of the rule-making process asserted that such methods did not adequately capture potential benefits from COOL (2008, p. 45128), and subsequently estimated consumer benefits as nonexistent. As consumers increasingly demand information about food attributes, and government may progressively play a larger role in information provision policies, developing consensus on the appropriate techniques to measure the ex ante benefit from providing consumers with information is important.

Finally, the projected negative impact of COOL on Mexico makes a strong case for broadening the impact analysis of regulations to include effects on trading partners and for policy makers to consider these welfare effects in the process of negotiating future trade agreements. In the U.S. context, this would require that the cost-benefit analysis for new regulations include assessment of impact on potentially affected countries as part of the net total welfare estimate. At the very least, more assessment is needed as to whether a regulation would undermine previously negotiated market access commitments.

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References

Awada, L., and A. Yiannaka. "Consumer Purchasing Decisions and Welfare Under Country of Origin Labeling Regulation." Paper presented at European Association of Agricultural Economists 98th Seminar, Crete, Greece, 29 June–2 July 2006.

Bredahl, M., A. Schmitz, and J. S. Hillman. "Rent Seeking in International Trade: The Great Tomato War." *Amer. J. Agr. Econ.* 69,1(1997):1–10.

Brester, G. W., J. M. Marsh, and J. A. Atwood. "Distributional Impacts of Country-of-Origin Labeling in the U.S. Meat Industry." *J. Agr. and Resour. Econ.* 29,2(2004):206–227.

Bureau, J.-C., S. Marette, and A. Schiavina. "Non-tariff Trade Barriers and Consumers' Information: The Case of the EU-US Trade Dispute over Beef." *Eur. Rev. Agr. Econ.* 25,4(1998):437–462.

Carter, C., B. Krissof, and P. A. Zwane. "Can Country-of-Origin Labeling Succeed as a Marketing Tool for Produce? Lessons from Three Case Studies." *Can. J. Agr. Econ.* 54(2006):513–560.

Carter, C. A., and A. P. Zwane. "Not so Cool? Economic Implications of Mandatory Country-of-Origin Labeling." Giannini Foundation, Dept. of Agr. and Resour Econ., University of California–Davis, 2003.

Chung, C., T. Zhang, and D. Peel. "Will Country of Origin Labeling (COOL) Be 'COOL' for the U.S. Meat Industry?" Paper presented at AAEA annual meetings, Denver, CO, 1–4 August 2004.

Ehmke, M. T. "International Differences for Consumer Preferences for Food Country of Origin: A Meta-analysis." Paper presented at AAEA annual meetings, Long Beach, CA, 23–26 July 2006.

Fulton, M., and K. Giannakas. "Inserting GM Products into the Food Chain: The Market and Welfare Effects of Different Labeling and Regulatory Regimes." *Amer. J. Agr. Econ.* 86,1(2004):42–60.

Giannakas, K., and M. Fulton. "Consumption Effects of Genetic Modification: What if Consumers Are Right?" *Agr. Econ.* 27(2001):97–109.

Grant, J. H., D. M. Lambert, and K. A. Foster, "A Seasonal Inverse Almost Ideal Demand System for North American Fresh Tomatoes." *Can. J. Agr. Econ.* 58,2(2010):215–234.

Josling, T., D. Roberts, and D. Orden. "Food Regulation and Trade: Toward a Safe and Open Global System." Institute for International Economics, Washington, DC, 2004.

[10] The 2003 Office of Management and Budget's circular A-4 does, however, provide guidance to federal agencies on how to use willingness-to-pay studies to quantify benefits as part of Executive Order 12866 Regulatory Impact Assessments.

Lucier, G., and A. Gerardo. "Vegetables and Melons: Situation Outlook Yearbook." Pub. No. VGS 2007. USDA/Economic Research Service, Washington, DC, 2007.

Lucier, G., B.-H. Lin, J. Allshouse, and L. S. Kantor. "Factors Affecting Tomato Consumption in the United States. Pub. No. VGS-282, USDA/Economic Research Service, Washington, DC, 2000.

Lusk, J. L., and J. D. Anderson. "Effects of Country-of-Origin Labeling on Meat Producers and Consumers." *J. Agr. and Resour. Econ.* 29,2(2004):185–205.

Mabiso, A., J. Sterns, J. VanSickle, and A. Wysocki. "When Buying Fresh Apples and Tomatoes Will Consumers Pay Extra to Have Country of Origin Labeling?" Pub. No. PBC 05-03, International Agricultural Trade and Policy Center, University of Florida, Gainesville, 2005.

Malaga, J., G. Williams, and S. Fuller. "U.S.-Mexico Fresh Vegetable Trade: The Effects of Trade Liberalization and Economic Growth." *Agr. Econ.* 26(2000):45–55.

Mussa, M., and S. Rosen. "Monopoly and Product Quality." *J. Econ. Theory* 18(1978):301–317.

Nimon, W., and J. Beghin. "Ecolabels and International Trade in the Textile and Apparel Market." *Amer. J. Agr. Econ.* 81,5(1999):1078–1083.

Peel, D. S. "A Summary of the Impact of U.S. Country of Origin Labeling (COOL) on the Mexican Beef Cattle Industry and U.S. Mexican Cattle and Beef Trade." Livestock Marketing Information Center, Oklahoma State Extension Services, 2003.

Plastina, A. S. "Essays on Innovations in the Agriculture and Food Industry Sectors." Unpub. Ph.D. diss., the Graduate College at the University of Nebraska, 2007.

Rude, J., I. Javis, and D. Brewin. "This Little Piggy Went to Market with a Passport: The Impacts of U.S. Country of Origin Labeling on the Canadian Pork Sector." *Can. J. Agr. Econ.* 54,3(2006):401–420.

Russo, C., R. Green, and R. Howitt. "Estimation of Supply and Demand Elasticities for California Products." Dept. of Agr. and Resour. Econ., University of California–Davis, 2008.

Sparks Companies, Inc. "COOL Cost Assessment." Prepared by the Sparks/CBW Consortium, Memphis, TN, April 2003.

Thompson, G. D., and P. N. Wilson. "The Organizational Structure of the North American Fresh Tomato Market: Implications for Seasonal Trade Disputes." *Agribus.: An Internat. J.* 13,5(1997):533–547.

Thompson, R. "Retail Demand for Greenhouse Tomatoes: Differentiated Fresh Produce." Paper presented at AAEA annual meetings, Montreal, Canada, 27–30 July 2003.

U.S. Department of Agriculture, Agricultural Marketing Service. "Mandatory Country of Origin Labeling Proposed Rule." *Federal Register* 68(2003):61944–61985.

———. "Mandatory Country of Origin Labeling Interim Final Rule." *Federal Register* 79(2008):45106–45151.

U.S. Department of Agriculture, Economic Research Service. "The Effects of NAFTA on Agriculture and the Rural Economy." Pub. No. WRS-02-1, USDA/ERS, Washington, DC, 2002.

———. "Tomato Trade Briefing Room." USDA/ERS,Washington, DC, 2004.

———. "Food CPI, Prices and Expenditures: Sales of Food at Home by Type of Outlet." USDA/ERS, Washington, DC, 2006. Online. Available at http://www.ers.usda.gov/Briefing/CPIFoodAndExpenditures/Data/table16.htm.

U.S. Department of Agriculture, National Agricultural Statistics Service. U.S. fresh tomato statistical data. USDA/NASS, Washington, DC, 2006.

U.S. Department of Commerce, International Trade Administration. "Suspension of Antidumping Investigation: Fresh Tomatoes from Mexico." *Federal Register* 73(2008):4831–4840.

U.S. Department of Commerce, U.S. Census Bureau. Foreign trade statistics. Washington, DC, 2008.

U.S. Department of Labor, Bureau of Labor Statistics. Tomato labor and price statistics. Washington, DC, 2006.

U.S. General Accounting Office. "Fresh Produce: Potential Consequences of Country of Origin Labeling." Pub. No. GAO/RCED-99-112, Washington, DC, April 1999.

———. "Country-of-Origin Labeling: Opportunities for USDA and Industry to Implement Challenging Aspects of the New Law." Pub. No. GAO-03-780, Washington, DC, August 2003.

Verlegh, P. W. J., and J. E. M. Steenkamp. "A Review and Meta-Analysis of Country of Origin Research." *J. Econ. Psychology* 20(1999):521–546.

Zago, A. M., and D. H. Pick. "Labeling Policies in Food Markets: Private Incentives, Public Intervention, and Welfare Effects." *J. Agr. and Resour. Econ.* 29,1(2004):150–165.

Appendix A: Data Used for Calibrating Simulation Model

Table A1. Simulation Model Variables and Sources

Data Variable	Use in Empirical Model	Data Estimation	Variable Parameters	Source
ε_{us} and ε_m	Short-run elasticity of supply for U.S. and Mexican fresh tomatoes (low estimate)	Estimate of calculated elasticities of supply using price and quantity data from 1974–1993.	ε_{us} = 0.07; ε_m = 0.19	Malaga, Williams, and Fuller (2000)
ε_{us} and ε_m	Short-run elasticity of supply for U.S. and Mexican fresh tomatoes (high estimate)	Calculated using price and production data from 1987–2002 for California fresh tomatoes for U.S. supply. For the corresponding high estimate of short-run elasticity of supply for Mexican tomatoes, we assume Mexican short-run elasticity of supply is relatively higher than the U.S. value based on the findings of Malaga, Williams, and Fuller (2000).	ε_{us} = 0.27; ε_m = 0.40	Russo, Green, and Howitt (2008)
η_n	Own-price elasticity of demand for unlabeled tomatoes in the pre-COOL scenario (low estimate)	Calculated using retail fresh tomato data from the time period of 1981–2004.	−0.32	Russo, Green, and Howitt (2008)
η_n	Own-price elasticity of demand for unlabeled tomatoes in the pre-COOL scenario (high estimate)	Average of uncompensated price elasticities of demand for fresh round tomatoes in six U.S. locations using 1999 data (excludes greenhouse, on-the-vine, roma, and cherry tomatoes).	−1.15	Thompson (2003, see table 5)
q_{nm}^{eq}	Equilibrium quantity of Mexican tomato consumption in the pre-COOL scenario	Fresh tomato imports from Mexico (2006) adjusted to account for percentage (70.2%) of tomatoes for at-home consumption (1994–96).	653.383 (1,000 tons)	U.S. Department of Commerce/U.S. Census Bureau, Foreign Trade Statistics (2008); Continuing Survey of Food Intakes by Individuals (CSFII) (Lucier et al., 2000)
q_{nu}^{eq}	Equilibrium quantity of U.S. tomato consumption in the pre-COOL scenario	U.S. production for fresh tomatoes (2006) less exports of fresh tomatoes (2006). Adjusted to account for percentage of tomatoes for at-home consumption (70.2%) based on 1994–96 data.	1,326.850 (1,000 tons)	USDA/National Agricultural Statistics Service (2006) and U.S. Department of Commerce/U.S. Census Bureau, Foreign Trade Statistics (2008) Continuing Survey of Food Intakes by Individuals (CSFII) (Lucier et al., 2000)

(continued . . .)

Table A1. Continued

Data Variable	Use in Empirical Model	Data Estimation	Variable Parameters	Source
q_n^{eq}	Total U.S. and Mexican tomato consumption in the pre-COOL scenario	$q_{nm}^{eq} + q_{nu}^{eq}$	1,980.233 (1,000 tons)	
p_n^{eq}	Equilibrium price for non-labeled tomatoes in pre-COOL scenario	12-month average retail price (2006) of field-grown fresh tomatoes adjusted 10% to account for waste and spoilage during marketing (excludes hothouse tomatoes)	\$3,126/ton (\$1.56/lb.)	U.S. Department of Labor, Bureau of Labor Statistics (2006); USDA/National Agricultural Statistics Service (2006) See Lucier and Gerardo (2007, table 94)
p_n^{eq} (farm-gate)	Price paid to U.S. growers or shippers by retailer and assumed price paid to Mexican grower-shipper by retailer in the pre-COOL scenario	12-month average FOB shipping point price (2006) for field-grown tomatoes (excludes hothouse tomatoes)	\$800/ton (\$0.40/lb.)	USDA/National Agricultural Statistics Service (2006) See Lucier and Gerardo (2007, table 94)

Appendix B:
Pre and Post- COOL Market Equilibria

In the pre-COOL setting, the equilibrium price for nonlabeled tomatoes (both U.S. and Mexican tomatoes combined) can be calculated by setting the nonlabeled demand [taken from text equation (1)] and retail supply [taken from text equation (10)] functions equal to each other,

(A1) $$(\mu_n^0 - p_n) / \mu_n^1 = (p_n - \delta_{num}^0) / \delta_{num}^1$$

and solving for the retail equilibrium price:

(A2) $$p_n^{eq} = (\delta_{num}^0 \mu_n^1 + \mu_n^0 \delta_{num}^1) / (\delta_{num}^1 + \mu_n^1).$$

The equilibrium price equation is then substituted into the inverse supply function [text equation (10)],

(A3) $$(\delta_{num}^0 \mu_n^1 + \mu_n^0 \delta_{num}^1) / (\delta_{num}^1 + \mu_n^1) = \delta_{num}^0 + \delta_{num}^1 q_n ,$$

in order to generate the pre-COOL retail equilibrium quantity,

(A4) $$q_n^{eq} = (\mu_n^0 - \delta_{num}^0) / (\delta_{num}^1 + \mu_n^1).$$

The retail-level market equilibrium price less the marketing margin represents the price paid to both U.S. and Mexican farmers at the pre-COOL market equilibrium. The relative equilibrium quantities of U.S. and Mexican production, q_{nu}^{eq} and q_{nm}^{eq}, together constituting the total equilibrium amount, can be derived by entering the equilibrium retail price, p_n^{eq}, amount paid to farmers plus the marketing margin, into the respective supply equations. The following expression illustrates the insertion of the retail price equilibrium equation into the pre-COOL Mexican supply equation:

(A5) $$q_{nm} = (p_n - \delta_{num}^0) / \delta_{num}^1 = \left[\left((\delta_{num}^0 \mu_n^1 + \mu_n^0 \delta_{num}^1) / (\delta_{num}^1 + \mu_n^1)\right) - \delta_{num}^0\right] / \delta_{num}^1 .$$

Simplification results in the following pre-COOL Mexican equilibrium quantity:

(A6) $$q_{nm}^{eq} = (\delta_{num}^0 \mu_{nl}^1 + \mu_n^0 \delta_{num}^1 - \delta_{nm}^0 \mu_n^1 - \delta_{num}^1 \delta_{nm}^0) / \left[(\delta_{num}^1 + \mu_n^1) \delta_{nm}^1\right].$$

The same process can be carried out to determine the pre-COOL U.S. equilibrium quantity:

(A7) $$q_{nu}^{eq} = (\delta_{num}^0 \mu_n^1 + \mu_n^0 \delta_{num}^1 - \delta_{nm}^0 \mu_n^1 - \delta_{num}^1 \delta_{nu}^0) / \left[(\delta_{num}^1 + \mu_n^1) \delta_{nu}^1 \right].$$

In the post-COOL setting, market-clearing quantities are determined by simultaneously solving the segregated marginal cost and demand functions. In order to determine the market-clearing quantity for U.S. tomatoes, q_{lu}^{eq}, first equate the post-COOL inverse Mexican supply and demand functions, and solve for q_{lm}:

(A8) $$q_{lm} = (\mu_n^0 - \mu_{lu}^1 q_{lu} - \delta_{lm}^0) / (\delta_{lm}^1 + \mu_{lm}^1).$$

Similarly, equate the post-COOL inverse U.S. supply and demand functions, and solve for q_{lm}:

(A9) $$q_{lm} = (\mu_n^0 - \mu_{lu}^1 q_{lu} - \delta_{lu}^0 - \delta_{lu}^1 q_{lu}) / (\delta_{lm}^1 + \mu_{lm}^1).$$

Equating these two equations and solving for q_{lu} generates the following market equilibrium quantity for U.S. tomatoes:

(A10) $$q_{lu}^{eq} = (\delta_{lu}^0 \delta_{lm}^1 + \mu_n^0 \mu_{lu}^1 + \delta_{lu}^0 \mu_{lm}^1 - \mu_n^0 \delta_{lm}^1 - \delta_{lm}^0 \mu_{lu}^1 - \mu_n^0 \mu_{lm}^1) / \left[(\mu_{lu}^1)^2 - \mu_{lu}^1 \delta_{lm}^1 - \mu_{lu}^1 \mu_{lm}^1 - \delta_{lu}^1 \delta_{lm}^1 - \mu_{lm}^1 \delta_{lu}^1 \right].$$

The same process (first solving for q_{lu} and then for q_{lm}) allows us to determine the equation for the equilibrium quantity of Mexican tomatoes:

(A11) $$q_{lm}^{eq} = (\delta_{lm}^0 \mu_{lu}^1 + \delta_{lm}^0 \delta_{lu}^1 - \mu_n^0 \delta_{lu}^1 - \delta_{lu}^0 \mu_{lu}^1) / \left[(\mu_{lu}^1)^2 - \mu_{lu}^1 \delta_{lm}^1 - \mu_{lu}^1 \mu_{lm}^1 - \delta_{lu}^1 \delta_{lm}^1 - \mu_{lm}^1 \delta_{lu}^1 \right].$$

The post-COOL equilibrium retail-level prices are derived by substituting the relevant equilibrium quantities into the following U.S. and Mexican inverse demand functions:

(A12) $$p_{lm} = \mu_n^0 - \mu_{lu}^1 q_{lu} - \mu_{lm}^1 q_{lm},$$

(A13) $$p_{lu} = \mu_n^0 - \mu_{lu}^1 q_{lm} - \mu_{lu}^1 q_{lu}.$$

The post-COOL U.S. and Mexican market equilibria prices less the marketing margin and costs of labeling represent the price paid to U.S. and Mexican farmers, respectively.