The Impacts of Food Safety Modernization Act on Fresh Tomato Industry:

An Application of a Two-Stage Geographic Import Demand System

Lisha Zhang
Assistant Professor, Department of Agricultural Sciences
Clemson University
Email: lishaz@clemson.edu

James Seale
Professor, Food and Resource Economics Department
University of Florida
Email: jseale@ufl.edu

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Abstract

The Food Safety Modernization Act (FSMA) was enacted to strengthen food safety standards in the US by shifting the focus of federal regulators to a strategy of actively preventing food contamination. The purpose of this study is to estimate the changes in quantity demanded for U.S food consumers and changes in revenues and profits for U.S. and for other food producers exporting food commodities to the U.S., after the adoption of the FSMA. In particular, we will focus on the fresh tomato industry. In order to calculate the quantity changes, conditional Cournot elasticities are estimated with two-stage geographic import demand systems based on different functional forms: the Rotterdam, CBS, Almost Ideal Demand System (AIDS), and NBR models, as well as a General model which nests on all four of these models. Our findings confirm that the compliance costs of the FMSA will have a significant impact on the structure of the fresh tomato industry. Because complying with the FMSA imposes different compliance cost burdens on food producers with different sizes of farms, we expect that once it is adopted, both domestic and foreign tomato producers with very small farms (as compared to those with larger farms) will see significant losses in both profit and market share.

Introduction

In recent years, rising concerns about foodborne illness and the globalization of food production and distribution have pressured US lawmakers to update and improve food safety regulations for the modern era. The Food Safety Modernization Act (FSMA), passed in 2011, attempts address these worries by regulating how food should be produced, processed, and distributed.

Compared to previous food safety laws and regulations, the FSMA shifts the focus on food safety in the U.S. away from a strategy of reaction and response, and toward one primarily of prevention. Most fundamentally, the law clarifies that the both domestic and foreign food producers – whether that be through the production, processing, transportation, marketing, or selling of food – must take responsibility for monitoring their own products and facilities, by identifying potential hazards that might cause food safety issues, and taking pre-emptive action to prevent those food safety issues from occurring. To that end, the FSMA authorizes the FDA to set scientific prevention-based rules and standards, in order to ensure a high rate of compliance by domestic food producers, as well as by foreign food producers who export food products to the US.

The FSMA puts a special emphasis on the regulation of imported foods. Under the new law, foreign food producers who wish to export products to the US must comply with regulations regarding issues such as "soil amendments, hygiene, packaging, temperature controls, animals in the growing area, and water" (Food and Drug Administration 2010). Imported products that fail to meet these standards will be denied entry into the US market.

Not all farms need to comply with the FSMA. Some food producers and processors are exempted, based on the sizes of their businesses. In particular, the smallest farms and businesses were granted exemptions from the FSMA, as they are more likely than larger farms to be harmed by the additional cost burdens imposed by the new law. According to FDA (2012), "there are approximately 189,636 farms in the US that grow produce for sale, excluding sprouting operations. This number includes farms with on-farm packing, farms with greenhouses, farms eligible for qualified exemptions, and farms that are not covered by the FSMA". Under the FSMA, farms are eligible for qualified exemptions if

> 1) The farm produces only for personal or on-farm consumption; 2) the farm's products are rarely consumed raw (e.g., squash); 3) the production process includes commercial processing to kill microorganisms; or 4) the farm has an average annual value of food sold during the previous three-year period of $25,000 or less, regardless of the type of produce sold. In other words, to qualify for a complete exemption from FSMA requirements, a farmer needs to either not sell produce at all, sell only low-risk or processed produce, or meet the $25,000 revenue cap. (Food and Drug Administration 2011)

In order to analyze the economic impacts of the FSMA on food producers, the FDA also defines different sizes of farms as follows:

> 1) Very Small Farms: farms with production of $250,000 or less in total monetary value of food per year; 2) Small Farms: farms with production of more than $250,000 but no more than $500,000 in total monetary value of food per year; and 3) Large Farms: farms with production of more than $500,000 in total monetary value of food per year. (Food and Drug Administration 2011)

According to the Final Rule (FDA 2015), covered farms have two years from the effective date to comply (i.e., they must comply by January 26, 2018). Small farms must comply within three years (i.e., by January 26, 2019). Very small businesses must comply within four years (i.e., by January 26, 2020). All covered farms will also have two more years to comply with requirements regarding agricultural water. However, “compliance dates for covered activities involving sprouts are sooner: three years for very small farms (i.e., January 26, 2019), two years for small farms (i.e., January 26, 2018); and one year for all other farms (i.e., January 26, 2017)” (FDA 2015).

The number of farms that are covered, not covered, or exempted by the FSMA’s proposed rules are estimated in a report by the FDA (FDA 2007), based on the Census of Agriculture (NASS 2007). As Table 1 shows, there are 113,870 farms that produce less than $25,000 worth of food and are therefore exempt from the FSMA, while there is a total of 40,211 farms that are covered by it. Among the covered farms, 26,947 are very small, 4,693 are small, and 8,571 are large. In total, 149,426 farms are either exempted or not covered by FSMA. Among the uncovered farms, 26,482 are very small, 4,454 are small, and 4,620 are large.

This disparity between farms of different size is important, because the expected impact of the FSMA on particular farms will depend importantly on the sizes of those farms. According to Paggi et al (2013), vegetable and fruit producers, as price takers, will have to comply with whatever rules and standards their buyers in fresh produce markets require, even if the compliance costs of those requirements are high for some producers. These compliance costs, in turn, will result in substantial structural change in the market (Hardesty and Kusunose 2009; Paggi et al. 2013). For instance, the adoption of new safety procedures in the production, harvesting, and processing of food will tend to impose additional costs on farms, as will possible third-party audit verification procedures. Moreover, the additional costs of adopting these procedures will tend to decrease, proportional to the size of the farm adopting them. In other words, on average, the negative impact of these compliance costs will tend to decrease as farm size increases. As a result, very small farms will tend to be harmed more than large farms.

In this study, we analyze whether the FSMA will have significantly different impacts on small farms, as compared to larger ones, in the fresh tomato industry. We do so by comparing revenue and profit changes for different sizes of farms. In order to do this, the most important step is to estimate the changes in quantity demanded that result from increases in price due to the increased costs associated with the FSMA. Next, through the farm panels, we estimate changes in production costs for different sizes of farm, and then based on those cost changes, we estimate the expected increase in market price for domestically produced tomatoes. Finally, we use a simulation approach to further calculate expected changes in quantity demanded, revenue, and profit for differently sized farms, both domestic and abroad, based on different assumptions about future price changes.

Data

Data on fresh tomatoes for this study are collected from the U.S. Department of Agriculture (USDA) and U.S. Department of Commerce (USDC). The data on U.S.-produced tomatoes are from the dataset the Economic Research Service (ERS), USDA (2015a). The data on values and quantities of imported commodities are from the Foreign Agricultural Service (FAS), USDA (2015b). Specifically, “U.S. customs districts” is selected from “data sources”; “import consumption” is selected from “product type”; “HS-4” is selected from “product group”. The data on expenditure and quantity of imported tomatoes from different origins are obtained from the dataset of “0702”. The period of analysis is 1989-2014.The prices of tomatoes are measured by supplier prices (the price farmers receive) for domestically produced tomatoes; the price of imported tomatoes is defined as the import value/import quantity.

Data on the size of tomato farms by area are obtained using census data from the National Agricultural Statistics Service (NASS, 2015). This dataset only includes the total farm size for fresh tomatoes. In order to be consistent with farm size as defined by the FDA, acreage areas for planted tomatoes are converted to the market values for fresh tomatoes with the following two steps: 1) calculate the average market value per acre for fresh tomatoes from 2010 to 2014, which is $13,085/acre, and 2) obtain the thresholds for different sizes of farms based on the FDA standards (Food and Drug Administration 2011) and average market value per acre (i.e., $25,000/($13,085/acre)=1.91 acres for exemption, $250,000/($13,085/acre)=19.11 acres for very small farms, $500,000/($13,085/acre)=38.22 acres for small farms, and anything above 38.22 acres for big farms). In other words, fresh tomato farms with farmlands smaller than 1.91 acres are exempt from complying with the FSMA, while other farm sizes are determined as follows: very small farms are between 1.92 and 19.11 acres, small farms are between 19.12 and 38.22 acres, and big farms are larger than 38.22 acres. The information on different sizes of fresh tomato farms is summarized in Table 2. The covered tomato farms account for 8.7% of total domestic tomato producers (7.3%+0.4%+1.0%). Among all covered farms, very small farms account for 84.4% of tomato producers, while small farms account for 4.5%, and large farms account for 11.1%.

In terms of the data on compliance costs, at this point, only the average compliance costs for all food commodities covered by the FSMA are available. So we use these average compliance costs for our study on fresh tomatoes. The compliance costs for different sizes of farms are summarized in Table 3 according to the Food and Drug Administration (2012). In this report, the estimated annual cost of the FSMA is approximately $459.66 million, assuming a 7% discount rate in future years. This works out to an estimated average cost of $11,430 per covered farm. It was also found that the cost of implementing the FSMA depends importantly on farm size. For instance, the total cost of applying the FSMA to very small, small, and large farms is $126.56 million, $60.88 million, and $261.96 million, respectively.

Estimated Market Prices of Fresh Tomatoes after the FSMA

The percentage increase in costs for different sizes of farms, along with overall market price changes, are summarized in Table 4. The percentage increase in cost for differently sized farms is equal to the average compliance cost for a given farm size, divided by the average annual production value for farms of that size. For example, the estimated average cost for very small farms is $4,697.19 per farm, and the average annual production value for very small farms is $75,279 per farm (see Table 4). Therefore, the percentage increases in cost for very small farms, as estimated by the FDA, is 6.2% (i.e., $4,697.19/$75,279 = 6.2%). Similarly, the percentage increases in cost for small and large farms are 4.0% and 1.2%, respectively, using FDA data

The expected increase in market price is the weighted average of the expected cost changes for each of the different sizes of farms. In this case, the market price is expected to increase by 5.6%, according data from Food and Drug Administration (FDA 2012) (i.e., 6.2%*84.4%+4.0%*4.5%+1.2%*11.1% = 5.6%). We chose to use data from 2014 as the benchmark for comparative analysis. The percentage increases in costs for tomato producers with different sizes of farm in other countries are assumed to be same as the cost increase for U.S. tomato producers. However, we cannot calculate the percentage increase in the market prices of imported tomatoes without knowing the number of farmers with different sizes of farms in each country exporting fresh tomatoes to the U.S. Therefore, by our assumption, although the percentage increases in cost are the same for domestic and foreign producers, the percentage increases in the market prices of fresh tomatoes may differ between the U.S. and foreign producers.

Differential Demand Systems

The differential demand system is conducted in a two-stage procedure by assuming that the consumer's preference between groups of commodities can be formulated by blockwise dependence. More specifically, in the first stage, the demand for home goods (from the U.S. in this case) and the demand for all imports are aggregated together and are then estimated conditional on the total expenditure on the particular commodity.

Accordingly, the first-stage demand system includes two equations: the demand equation for home products and the demand equation for all imported products as a whole. In the second stage, the total import expenditure on all imports then is allocated among the imported goods from different source countries. In other words, the first stage analyzes the relationship between domestically produced and imported goods as a whole, while the second stage analyzes the interactions among imports from individual countries. In both stages, expenditure and price elasticities are estimated. By properly multiplying between the elasticities estimated from stages one and two, the second-stage elasticities are converted to first-stage elasticities.

For each stage, we consider five different differential demand systems: Rotterdam (Barten 1964, Theil 1965), AIDS (Deaton and Muellbauer 1980), CBS

(Keller and Van Driel 1985), NBR (Neves 1987), and the General model in which the four models are nested. We then choose from these the most appropriate model in terms of best fitting the data

The General model for the first stage, in which the four models are nested, is specified as

$$W_g d\log q_g = \left(\delta_1 W_g + d_g\right) d\log Q_g + \sum_h [e_{gh} - \delta_2 W_g \,(\delta_{gh} - W_h)] d\log P_h \qquad (1)$$

where $g = I, D,$ and I represents imports and D represents the domestically produced good. δ_{gh} is the Kronecker delta (($\delta_{ij} = 1$ if $g = h$; $\delta_{ij} = 0$ if $g \neq h.$). P_g is the price for group s_g in the first stage, respectively. W_I ($W_I = \sum_{i \in s_I} w_i$) and W_D are the budget shares for the group of imported tomatoes and domestically produced tomatoes in the first stage, respectively.

$$d\log\left(Q_g\right) = W_I d\log(Q_I) + W_D d\log(Q_D) \qquad (2)$$

Is the Divisia volume index for group s_g.

In the second stage of the model, the demands for the imported goods from individual countries are estimated conditional on total expenditures on imports. In other words, the total import expenditure is allocated among all the different import countries. Unlike the first stage, which involved only two groups of goods (home good and all imports), the second stage includes imports from all individual source countries. In this stage, the number of equations in the demand system is equal to the number of importing source countries.

The General model for the second stage for good k from source $i \in S_I$ is

$$w_i^* d\log q_i = (\delta_1^* w_i^* + d_1^*) d\log Q_I + \sum_j [e_{ij}^* - \delta_2^* \, w_i^* (\delta_{ij}^* - w_j^*)] d\log p_j \qquad (3)$$

where $w_i^* = \frac{w_i}{W_I}$, and $\delta_1^*, d_1^*, e_{ij}^*$ and δ_2^*, are constant parameters to be estimated in the second stage. δ_{ij}^* is the Kronecker delta ($\delta_{ij} = 1$ if $i = j$; $\delta_{ij} = 0$ if $i \neq j$).

In each stage, the demand restrictions are tested with log-likelihood ratio test. The demand restrictions on the first (1) and second stage (2) General models are

Adding-up $\sum_i d_i = 1 - \delta_1$ and $\sum_i e_{ij} = 0$;

Homogeneity $\sum_j e_{ij} = 0$, and

Symmetry $e_{ij} = e_{ji}$.

By restricting δ_1 and δ_2 as shown below, we arrive at the four competing demand systems:

Rotterdam $\delta_1 = 0$ and $\delta_2 = 0$ *;*

CBS $\delta_1 = 1$ and $\delta_2 = 0$ *;*

AIDS $\delta_1 = 1$ and $\delta_2 = 1$ *;* and

NBR $\delta_1 = 0$ and $\delta_2 = 1$.

With the parameters from the first and second stages, expenditure and price elasticities for goods from each source country (including the home country) are estimated conditional on the total expenditure, that is, first-stage elasticities. According to Muhammad et al. (2011), the elasticities are specified as follows:

First-stage expenditure elasticity conditional on the total expenditure:

$$\eta_i^u = \eta_g \eta_i^* \quad i \in S_I \tag{4}$$

where $\eta_g = \frac{(\delta_1 W_I + d_g)}{W_I}$ and $\eta_i^* = \frac{(\delta_1^* w_i^* + d_1^*)}{w_i^*}$ are the income elasticities from the first and second stages, respectively.

First-stage conditional Slutsky price elasticity conditional on the total expenditure:

$$\varepsilon_{ij}^{u} = \frac{\pi_{ij}^{u}}{\bar{w}_{i}^{u}} = \varepsilon_{ij}^{*} + \Phi_g \eta_i^{*} \ \ \eta_j^{*} \ \ w_j^{*} \ (1 - W_g \eta_g) \qquad i, j \in \ S_I \tag{5}$$

where $\Phi_g = \frac{\phi \Theta_g}{W_g}$, $\Theta_g = \delta_1 W_g + d_g, W_g,$ and η_g are income flexibility, marginal share, group budget share, and expenditure elasticity for group g in the first stage, respectively, while $\varepsilon_{ij}^{*} = \frac{e_{ij}^{*}}{w_i^{*}} - \delta_2^{*}(\delta_{ij}^{*} - w_j^{*})$, η_j^{*}, and w_j^{*} are second-stage conditional Slutsky price elasticity, second-stage conditional expenditure elasticity, and second-stage conditional budget share for good j in the second stage, respectively.

First-stage conditional Cournot price elasticity conditional on the total expenditure:

$$C_{ij}^{u} = \varepsilon_{ij}^{u} - \ \eta_i^{*} \ \ w_j^{*} \eta_g W_g \tag{6}$$

where ε_{ij}^{u} is the first-stage conditional Slutsky price elasticity estimated from equation (5).

All parameters from (4), (5) and (6) are estimated in either stage one or stage two, except for ϕ, the income flexibility. Although Frisch (1959) has famously conjectured that "ϕ should increase in absolute value as the consumer becomes more affluent" (Frisch 1959). Most tests of the Frisch conjecture, such as Clements and Theil (1996), Theil (1976), Theil and Brooks (1972), tend to reject it. Many researches have attempted to identify the value of income flexibility if it is invariant. Brown and Deaton (1972), who review past findings on the subject, conclude that "there would seem to be fair agreement on the use of a value of ϕ around minus one half". This finding is supported by other empirical studies, such as Clements (2008), Chen and Clements

(1999), and Theil (1987). Thus, in this study, we follow the previous findings and assume that income flexibility ϕ is -0.5.

Results

The first stage model is conditional on the total expenditure on U.S. domestically produced and imported tomatoes. Only two sources of tomato production are included (i.e., the U.S., and all imports as a whole). Therefore, the symmetry restriction is automatically imposed when homogeneity is imposed. Homogeneity is not rejected by any models. In terms of model selection, only the NBR (5.10) model is not rejected in the first stage (Table 5). Thus, we select the NBR model as the best model to fit the data in the first stage. The second stage is conditional on the total import expenditure on imported tomatoes. The results of the tests for homogeneity, symmetry, and model selection in the second stage are reported in the Table 6. Specifically, homogeneity and symmetry are not rejected by any of the five models, and the CBS and AIDS models in the second stage are found to best fit the second-stage data.

When the NBR model is applied in the first stage and the CBS and AIDS models are applied in the second stage, the conditional first-stage Cournot own-price elasticities are negative for home-produced and imported fresh tomatoes from all sources(Column 8, Table 7). Across all the countries considered, conditional first-stage Cournot own-price elasticities indicate that fresh tomatoes produced in R.O.W. are the most sensitive to an own-price change and fresh tomatoes produced in the U.S. are the least sensitive to an own-price change. For Cournot cross-price elasticities, the pair of Import-US is significant. Also, most pairs are not significant at the 90% confidence level, except for that of Mexico-Canada in the CBS model calculated (Table 7). This result indicates that most import countries are not sensitive to price changes of fresh tomatoes imported from other import countries.

Revenue Changes for Fresh Tomato Producers after FSMA

With the conditional Cournot elasticities, the changes of quantities can be estimated. The next step is to estimate the change of revenues. In order to calculate revenue changes, we need to know the market prices of and changes in quantities demanded for fresh tomatoes, as well as how these considerations affect farms of different sizes. The first step is to compute the change in supply for tomatoes from different sizes of farms. Tomato farmers adjust their production in response to changes in input costs and output prices. In this case, the quantity of tomatoes supplied by different sizes of farms will depend on the increase in cost after those farms adopt the FSMA. When output price remains the same, the decrease in the quantity supplied is equal to the decrease in the quantity demanded, if the increase in cost is transmitted to the increase in price. For example, if the increase in cost is 6.2% for very small farms, and the increase in cost fully transmits to the market price, then the market price will increase by 6.2%, and quantity demanded will decrease accordingly. The decrease in supply for very small farms is then equal to the decrease in quantities demanded when market price increases 6.2%. Finally, as discussed previously, we assume that the market price increases by some amount between 0% and 5.6%.

When the market price increases, the changes in revenue for U.S. farmers with different sizes of farm are positive and will increase as much as the price itself increases (Table 8). This is because conditional Cournot own- and cross-price elasticities are statistically zero for domestic tomatoes. As a result, the change in the price will not affect the quantities demanded. So, U.S. producers can expect that their revenues will increase after the FSMA. Import producers, however, will be much more significantly affected by the FSMA. Specifically, very small and small farms will all have negative revenue changes. Big farms can expect positive revenue changes only when the market price increases by at least 2% to 3% (Table 8).

If we convert elasticities from the second stage to first stage elasticities, which is conditional on the total expenditure on both domestically produced and imported tomatoes, we can also calculate the changes in revenue for different sizes of farms, based on either FDA (2012). We start from the revenue analysis using the CBS model (Table 9) and the AIDS model (Table 10).

Begin by considering very small farms. According to the AIDS model (Table 10), producers from all import countries will see negative revenue changes when import prices increase by 5.6% or less. According to the CBS model, however, producers from Canada and the Netherlands will see their revenue increase if import prices increase by more than 0% (Table 9). This is because, according to the CBS model, the conditional Cournot price elasticities are zero for tomatoes produced in the Netherlands and Canada. As a result, the change in quantities demanded is zero, and so revenue will increase along with the import prices. But the conditional Cournot price elasticities are not zero for the AIDS model, and so according to this model revenue will decrease for all very small farms.

For small farms, producers from Mexico will increase their revenue if the import price increases by at least 4%-5%, according to both the CBS and AIDS models (Table 9 and Table 10). Depending on the model used, producers in Canada and the Netherlands are predicted to see positive revenue changes when the import price increases either by 0% or more (CBS) or by 3%-4% or more (AIDS).

Finally, with respect to big farms, producers from Mexico and R.O.W. are expected to see their revenue increase as long as prices increase by at least 1%-2%, according to both models (Table 9 and Table 10). Producers from Canada and the Netherlands will see their revenues increase when import prices increase either by at least 0% (CBS, Table 9) or by at least 1%-2% (AIDS, Table 10).

Profit Changes for Fresh Tomato Producers after FSMA

With the revenue changes, we are able to estimate profit changes for domestic and foreign tomato producers exporting fresh tomatoes to the U.S. market. More specifically, if the increase in cost fully transmits to the market price, then profit changes equal revenue changes calculated from the previous section minus cost changes for different sizes of farms

As the Table 11 shows, both the domestic and import producers with very small farms can expect that their profit will decrease after FSMA For producers with small farms, domestic farmers will have positive profit changes when market price increase by at least 4% (Table 11). By contrast, import producers, as a group, will see negative profit changes if market prices increase from 1% to 5.6%. For producers with big farms, import farmers can expect positive profit changes only when the market price increases by at least 3% to 4%. U.S farmers can have positive profit changes if the market price increases by at least 1% to 2% (Table 11).

If we convert elasticities from second-stage to first-stage elasticities, which are conditional on the total expenditure on both domestically produced and imported fresh tomatoes, we can calculate the changes in profits for farmers with different sizes of farms (Table 12 and Table 13). For very small farmers from all import countries, profit changes are negative based on both the CBS and AIDS models. In other words, their profits decrease when import prices increase by an amount between 1%-5.6% (Table 12 and Table 13). Like very small farms, most small farms will decrease their profits except for farms in the Netherlands and Canada. According to the CBS model, producers with small farms in the Netherlands and Canada will see their profits increase if import prices of their fresh tomatoes increase above 4% (Table12), although according to the AIDS model they will not see profit gains from any price increases (Table 13). For big farms, producers from Mexico will increase their profits if the import price of their fresh tomatoes increases by at least 2%-3%, according to both the CBS and AIDS models (Table 12 and Table 13). Producers with the big size of farms in Canada and the Netherlands will have positive profit changes when the price of their fresh tomatoes increases either by 1%-2% or more (CBS) or by 2%-3% or more (AIDS). Big farms from R.O.W. will have positive profit changes if price of their fresh tomatoes increases by at least 2%-3% (Table 12 and Table 13).

Conclusion

The FSMA is a significant step towards creating a more systematic and scientifically supported approach to addressing food safety issues, but some concerns have been raised about how its compliance costs will eventually affect food producers with small and very small farms. The additional costs imposed by complying with the FSMA would significantly reduce their market shares, and may even force them to exit the market entirely, as the average compliance costs are significantly higher for smaller farms than for bigger farms.

Our findings confirm that the compliance costs of the FMSA will have a significant impact on the structure of the fresh tomato industry. Because complying with the FMSA imposes different compliance cost burdens on food producers with different sizes of farms, we expect that once it is adopted, both domestic and foreign tomato producers with very small farms (as compared to those with larger farms) will see significant losses in both profit and market share. This is important, because from the perspective of the market as a whole, very small and small farms play an important competitive role, ensuring variation in what would otherwise be a highly concentrated market. Thus, insofar as new regulatory policies (such as the FSMA) adversely impact the economic viability of smaller farms and food producers, such policies will also tend to negatively impact competition in the market. Such lack of competition can have a number of negative impacts, including a reduction in the diversity of foods available, and an increase in the price of food. This poses a dilemma. US consumers, on the one hand, certainly stand to benefit from improved and modernized food safety regulations. But, on the other hand, too much regulation may harm consumers by giving them fewer available choices in addition to higher prices. The clear implication of our analysis, then, is that in implementing the FSMA, the FDA should be aware of the potential adverse effects that additional food safety regulations may have on food producers, consumers, and market structures. In essence, the FDA needs to execute a delicate balancing act by achieving its primary goal of improving food safety standards, while also minimizing the potential negative impacts those regulations may have on market performance.

Table 1. FDA Accounting of Farms Eligible for Qualified Exemptions and Covered and Not Covered by FSMA, in 2007

	$25K or less monetary value of food produced	Very Small	Small	Large	Total
Total Number of Farms	113,870	53,429	9,147	13,191	189,637
Total Covered Farms	-	26,947	4,693	8,571	40,211
Total Farms Exempt/Not Covered	113,870	26,482	4,454	4,620	149,426

Source: Food and Drug Administration, USDA, 2012

Table 2. Summary of Fresh Tomato Producers with Different Sizes of Farm

Farm Size	Not Covered	Very Small	Small	Large
Number of Farms	28349.2	2277.1	121.7	299.0
% of All Farms	91.3%	7.3%	0.4%	1.0%
% of Covered Farms		84.4%	4.5%	11.1%

Source: National Agricultural Statistics Service, USDA, 2015

Table 3. Summary of Costs of FSMA Compliance (in millions) from FDA (2012)

Cost Sections	Not Covered	Very Small	Small	Large	Total
Administrative cost to learn the rule	$10.06	$11.82	$5.38	$9.53	$36.79
Health and Hygiene	$0.00	$27.18	$15.06	$95.97	$138.21
Agricultural water	$0.00	$27.45	$7.09	$14.00	$48.55
Biological soil amendments of animal origin	$0.00	$1.11	$1.04	$7.06	$9.20
Domesticated and wild animals	$0.00	$10.32	$5.96	$21.50	$37.78
Growing, harvesting, packing, and holding activities	$0.00	$0.17	$0.09	$0.16	$0.42
Equipment, tools, buildings, and sanitation	$0.00	$11.38	$8.22	$39.27	$58.87
Sprouting operations	$0.00	$0.75	$0.71	$6.07	$7.53
Personnel Qualifications and training	$0.00	$19.60	$12.84	$58.98	$91.42
Corrective steps	$0.00	$0.59	$0.28	$1.23	$2.09
Variances	$0.00	$0.00	$0.00	$0.00	$0.10
Recordkeeping	$0.00	$16.19	$4.21	$8.19	$28.60
Total Costs (annual in millions)	$10.06	$126.56	$60.88	$261.96	$459.56
Average Cost per farm	$88.33	$4,697.19	$12,972.36	$30,566.23	$11,429.70

Source: Food and Drug Administration, USDA, 2012

Table 4. Summary of Changes in Fresh Tomato Costs and Expected Change in Market Price after FSMA

	Very Small	Small	Large	Expected % increase in Market Price
% of Covered Farms	84.4%	4.5%	11.1%	
Average Food Sales per Farm (FDA Estimation)	$75,279	$320,696	$2,638,384	
Average Cost per Farm (FDA Estimation)	$4,697.19	$12,972.36	$30,566.23	
Average Cost per Farm (Informa Economics Estimation)	$6,570.32	$17,292.87	$33,313.22	
% Increase in Cost (FDA Estimation)	6.2%	4.0%	1.2%	5.6%

Source: Food and Drug Administration, USDA, 2012

Table 5. Log-likelihood-ratio test statistics for different restrictions in the General, Rotterdam, CBS, AIDS, and NBR models for the first stage

	General	Rotterdam	CBS	AIDS	NBR		
	$-2[(L(\theta^R) - L(\theta^U)]$					$\chi^2(0.05)$	DF [a]
Homogeneity	0.09	1.12	0.97	0.37	0.47	3.84	1
Homogeneity Symmetry	0	0	0	0	0	3.84	1
Model Selection	-	9.27	10.19	6.21	5.10	5.99	2

[a] DF=Degree of Freedom.

Table 6. Log-likelihood-ratio test statistics for different restrictions in the General, Rotterdam, CBS, AIDS, and NBR models for the one-stage model excluding demand for domestic production of Fresh Tomatoes

	General	Rotterdam	CBS	AIDS	NBR		
	$-2[(L(\theta^R) - L(\theta^U)]$					$\chi^2(0.05)$	DF [a]
Homogeneity	4.21	2.00	2.40	4.11	2.97	7.81	3
Homogeneity Symmetry	1.51	0.68	0.92	0.69	0.11	12.59	6
Model Selection	-	9.49	2.95	3.30	11.99	5.99	2

[a] DF=Degree of Freedom.

Table 7. Cournot (uncompensated) price elasticities conditional on total expenditure on domestically produced and imported fresh tomatoes calculated

Conditional Cournot Cross-Price Elasticities [c]							Conditional Cournot Own-Price Elasticities

NBR model in the first stage, CBS model in the second stage

(1)	U.S. (2)	All Imports (3)	Mexico (4)	Canada (5)	Netherlands (6)	R.O.W. (7)	(8)
U.S.	-	0.02	-	-	-	-	-0.13
All Imports	-1.2*** [b]	-	-	-	-	-	-1.02***
Mexico	-	-	-	-0.14**	-0.03	-0.01	-0.89***
Canada	-	-	-0.60	-	0.04	0.06	-0.29*
Netherlands	-	-	-0.53	0.19	-	0.01	-0.44
R.O.W. [a]	-	-	-0.12	0.54	0.03	-	-1.04***

NBR model in the first stage, AIDS model in the second stage

(1)	U.S. (2)	All Imports (3)	Mexico (4)	Canada (5)	Netherlands (6)	R.O.W. (7)	(8)
U.S.	-	0.02	-	-	-	-	-0.13
All Imports	-1.2***	-	-	-	-	-	-1.02***
Mexico	-	-	-	-0.04	-0.01	0.00	-1.01***
Canada	-	-	0.00	-	0.07	0.03	-0.89***
Netherlands	-	-	-0.10	0.32	-	0.01	-0.94***
R.O.W.	-	-	0.14	0.25	0.02	-	-1.23***

[a] R.O.W. = Rest of World.

[b] *.** and*** indicate significance level of 10%, 5%, and 1%, respectively

[c] $C_{ij}^{u} = \varepsilon_{ij}^{u} - \eta_i^{*}\ \bar{w}_j^{*}\eta_g\bar{w}_g$ where ε_{ij}^{u} is Slutsky price elasticity conditional on the total expenditure. $\eta_i^{*}\ and\ \bar{w}_j^{*}$ are conditional expenditure elasticity for good i, and conditional budget share for good j in the second stage, respectively. $\bar{W}_g\ and\ \eta_g$ are budget share and expenditure elasticity for group g in the first stage, respectively

Table 8. Percentage Change in Revenues for Fresh Tomato Producers after FSM Estimated Using the NBR Model

Countries	U.S Price Increase 5.6% and Import Price Increases by						
	0%	1%	2%	3%	4%	5%	5.6%
	Very Small Farms (Costs Increase by 6.2%)						
U.S.	0.00%	1.00%	2.00%	3.00%	4.00%	5.00%	5.60%
All Imports	-13.76%	-12.90%	-12.04%	-11.18%	-10.31%	-9.45%	-8.93%
	Small Farms (Costs Increase by 4%)						
U.S.	0.00%	1.00%	2.00%	3.00%	4.00%	5.00%	5.60%
All Imports	-8.88%	-7.97%	-7.06%	-6.15%	-5.24%	-4.32%	-3.78%
	Big Farms (Cost Increase by 1.2%)						
U.S.	0.00%	1.00%	2.00%	3.00%	4.00%	5.00%	5.60%
All Imports	-2.66%	-1.69%	-0.72%	0.26%	1.23%	2.20%	2.79%

Table 9. Percentage Change in Revenues for Fresh Tomato Producers after FSMA Estimated Using the CBS Model

Countries	Import Price Increases by						
	0%	1%	2%	3%	4%	5%	5.6%
	Very Small Farms (Costs Increase by 6.2%)						
Mexico	-6.39%	-5.45%	-4.51%	-3.58%	-2.64%	-1.71%	-1.14%
Canada	0.00%	1.00%	2.00%	3.00%	4.00%	5.00%	5.60%
Netherlands	0.00%	1.00%	2.00%	3.00%	4.00%	5.00%	5.60%
R.O.W	-6.45%	-5.51%	-4.58%	-3.64%	-2.71%	-1.77%	-1.21%
	Small Farms (Costs Increase by 4%)						
Mexico	-4.12%	-3.16%	-2.20%	-1.24%	-0.28%	0.67%	1.25%
Canada	0.00%	1.00%	2.00%	3.00%	4.00%	5.00%	5.60%
Netherlands	0.00%	1.00%	2.00%	3.00%	4.00%	5.00%	5.60%
R.O.W	-4.16%	-3.20%	-2.24%	-1.28%	-0.33%	0.63%	1.21%
	Big Farms (Cost Increase by 1.2%)						
Mexico	-1.24%	-0.25%	0.74%	1.73%	2.71%	3.70%	4.29%
Canada	0.00%	1.00%	2.00%	3.00%	4.00%	5.00%	5.60%
Netherlands	0.00%	1.00%	2.00%	3.00%	4.00%	5.00%	5.60%
R.O.W	-1.25%	-0.26%	0.73%	1.71%	2.70%	3.69%	4.28%

[a] R.O.W. = Rest of World

Table 10. Percentage Change in Revenues for Fresh Tomato Producers after FSMA Estimated Using the AIDS Model

Countries	Import Price Increases by						
	0%	1%	2%	3%	4%	5%	5.6%
	Very Small Farms (Costs Increase by 6.2%)						
Mexico	-6.26%	-5.32%	-4.39%	-3.45%	-2.51%	-1.58%	-1.01%
Canada	-5.52%	-4.57%	-3.63%	-2.68%	-1.74%	-0.79%	-0.23%
Netherlands	-5.83%	-4.89%	-3.94%	-3.00%	-2.06%	-1.12%	-0.55%
R.O.W	-7.63%	-6.70%	-5.78%	-4.85%	-3.93%	-3.01%	-2.45%
	Small Farms (Costs Increase by 4%)						
Mexico	-4.04%	-3.08%	-2.12%	-1.16%	-0.20%	0.76%	1.33%
Canada	-3.56%	-2.60%	-1.63%	-0.67%	0.30%	1.26%	1.84%
Netherlands	-3.37%	-2.80%	-1.84%	-0.87%	0.09%	1.05%	1.63%
R.O.W	-4.92%	-3.97%	-3.02%	-2.07%	-1.12%	-0.17%	0.40%
	Big Farms (Cost Increase by 1.2%)						
Mexico	-1.21%	-0.22%	0.76%	1.75%	2.74%	3.73%	4.32%
Canada	-1.07%	-0.08%	0.91%	1.90%	2.89%	3.88%	4.47%
Netherlands	-1.13%	-0.14%	0.85%	1.84%	2.83%	3.82%	4.41%
R.O.W	-1.48%	-0.49%	0.49%	1.48%	2.46%	3.45%	4.04%

[a] R.O.W. = Rest of World

Table 11. Percentage Change in Profits for Fresh Tomato Producers after FSMA Estimated Using the NBR Model in the First Stage,

Countries	U.S Price Increases 5.6% and Import Price Increases by						
	0%	1%	2%	3%	4%	5%	5.6%
	Very Small Farms (Costs Increase by 6.2%)						
U.S.	-6.20%	-5.20%	-4.20%	-3.20%	-2.20%	-1.20%	-0.60%
All Imports	-19.96%	-19.10%	-18.24%	-17.38%	-16.51%	-15.65%	-15.13%
	Small Farms (Costs Increase by 4%)						
U.S.	-4.00%	-3.00%	-2.00%	-1.00%	0.00%	1.00%	1.60%
All Imports	-12.88%	-11.97%	-11.06%	-10.15%	-9.24%	-8.32%	-7.78%
	Big Farms (Cost Increase by 1.2%)						
U.S.	-1.20%	-0.20%	0.80%	1.80%	2.80%	3.80%	4.40%
All Imports	-3.86%	-2.89%	-1.92%	-0.94%	0.03%	1.00%	1.59%

Table 12. Percentage Change in Profits for Fresh Tomato Producers after FSMA Estimated Using the CBS Model in the Second Stage

Countries	Import Price Increases by						
	0%	1%	2%	3%	4%	5%	5.6%
			Very Small Farms (Costs Increase by 6.2%)				
Mexico	-12.59%	-11.65%	-10.71%	-9.78%	-8.84%	-7.91%	-7.34%
Canada	-6.20%	-5.20%	-4.20%	-3.20%	-2.20%	-1.20%	-0.60%
Netherlands	-6.20%	-5.20%	-4.20%	-3.20%	-2.20%	-1.20%	-0.60%
R.O.W	-12.65%	-11.71%	-10.78%	-9.84%	-8.91%	-7.97%	-7.41%
			Small Farms (Costs Increase by 4%)				
Mexico	-8.12%	-7.16%	-6.20%	-5.24%	-4.28%	-3.33%	-2.75%
Canada	-4.00%	-3.00%	-2.00%	-1.00%	0.00%	1.00%	1.60%
Netherlands	-4.00%	-3.00%	-2.00%	-1.00%	0.00%	1.00%	1.60%
R.O.W	-8.16%	-7.20%	-6.24%	-5.28%	-4.33%	-3.37%	-2.79%
			Big Farms (Cost Increase by 1.2%)				
Mexico	-2.44%	-1.45%	-0.46%	0.53%	1.51%	2.50%	3.09%
Canada	-1.20%	-0.20%	0.80%	1.80%	2.80%	3.80%	4.40%
Netherlands	-1.20%	-0.20%	0.80%	1.80%	2.80%	3.80%	4.40%
R.O.W	-2.45%	-1.46%	-0.47%	0.51%	1.50%	2.49%	3.08%

[a] R.O.W. = Rest of World

Table 13. Percentage Change in Profits for Fresh Tomato Producers after FSMA Estimated Using the AIDS Model in the Second stage

Countries	Import Price Increases by						
	0%	1%	2%	3%	4%	5%	5.6%
	Very Small Farms (Costs Increase by 6.2%)						
Mexico	-12.46%	-11.52%	-10.59%	-9.65%	-8.71%	-7.78%	-7.21%
Canada	-11.72%	-10.77%	-9.83%	-8.88%	-7.94%	-6.99%	-6.43%
Netherlands	-12.03%	-11.09%	-10.14%	-9.20%	-8.26%	-7.32%	-6.75%
R.O.W	-13.83%	-12.90%	-11.98%	-11.05%	-10.13%	-9.21%	-8.65%
	Small Farms (Costs Increase by 4%)						
Mexico	-8.04%	-7.08%	-6.12%	-5.16%	-4.20%	-3.24%	-2.67%
Canada	-7.56%	-6.60%	-5.63%	-4.67%	-3.70%	-2.74%	-2.16%
Netherlands	-7.37%	-6.80%	-5.84%	-4.87%	-3.91%	-2.95%	-2.37%
R.O.W	-8.92%	-7.97%	-7.02%	-6.07%	-5.12%	-4.17%	-3.60%
	Big Farms (Cost Increase by 1.2%)						
Mexico	-2.41%	-1.42%	-0.44%	0.55%	1.54%	2.53%	3.12%
Canada	-2.27%	-1.28%	-0.29%	0.70%	1.69%	2.68%	3.27%
Netherlands	-2.33%	-1.34%	-0.35%	0.64%	1.63%	2.62%	3.21%
R.O.W	-2.68%	-1.69%	-0.71%	0.28%	1.26%	2.25%	2.84%

[a] R.O.W. = Rest of World

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