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Import Rules for FMD Contaminated Beef

by

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Abstract

Under the new WTO trading rules the United States is obligated to revise its beef import policy and has proposed barriers based on classifying nations according to livestock health risks. This research develops a model which captures the impact of various degrees of FMD risk from imports on setting import barriers. The results show that nations classified as high risk for FMD continue to face prohibitive barriers. As outbreak risk falls so does the level of the barrier levied against that exporter. The barrier levels are also sensitive to the expected social losses as influenced by alternative control strategies.

Key words: Beef, Foot-and-Mouth disease, risk, SPS barriers

IMPORT RULES FOR FMD CONTAMINATED BEEF

A framework for linking the level of a trade barrier to the health risk contained in imports is shown by Paarlberg and Lee (1998). To illustrate how the risk of importing products containing Foot-and-Mouth Disease (FMD) affects the welfare optimizing tariff, they use a simple model of beef trade. The level of a welfare maximizing tariff levied by the United States is affected by the risk of beef from one exporter containing Foot-and-Mouth Disease as well as the expected loss in national beef output. Greater risks of importing beef containing FMD result in larger tariffs against the exporter of contaminated beef. Also larger expected national output losses cause larger tariffs. When the risk is low and the expected output loss is slight, the discriminatory tariff due to FMD is negligible. When the risk of importing FMD is high and the expected output loss is great, then the discriminatory tariff is prohibitive.

This paper expands the theoretical and empirical models used in the Paarlberg and Lee article to more closely match the import regulations on livestock and meat proposed by the United States. This model treats the output losses as a random variable and links imported quantities to the probability of experiencing an FMD outbreak. Whereas, the previous model considered only two exporting countries, a clean exporter and an infected exporter, this model adds multiple exporting regions each with a different probability of exporting FMD to the United States. The result is a vector of barriers levied against exporting regions that reflect differing probabilities of exporting FMD to the United States. .

This article begins with an overview of the proposed new U.S. import rules regarding Foot-and-Mouth Disease. These rules form essential components of the model. Subsequently, a conceptual model is developed which blends the proposed U.S. rules into a trade framework. The conceptual model generates rules for setting import barriers and forms the basis of the empirical model and its results which follow in the next section.

Proposed U.S. Rules on Trade with Nations having FMD

In the Uruguay Round under the General Agreement on Tariffs and Trade a new Sanitary and Phytosanitary (SPS) Agreement was signed. That agreement requires nations to base SPS rules on scientific evidence, on acceptable risk criteria, and to recognize disease-free regions. To comply with the new SPS agreement, the United States proposed changes in its import rules for livestock and meat.[1]

Whereas under the old U.S. policy nations were classified as either free or not-free of FMD, the proposed rules classify nations and regions according to one of six risk levels. The categorization of a nation's or region's FMD risk can be done using either qualitative criteria or a quantitative assessment of the probability of FMD appearing in the national livestock herd. Five categories of risk have probability thresholds. Regions are assumed to be of negligible risk (RN) if fewer than one out of one million live animals in that region would be expected to be infected. Regions of slight risk (R1) would be expected to have fewer than one out of one-hundred thousand animals infected. Low risk regions (R2) have a probability of one out of ten thousand; with moderate risk regions (R3) having a probability of one out of one thousand; and high (R4) one out of one hundred. A sixth category is designated for regions with unknown risk (RU) and this category is treated as a high risk (R4) category.

Increasing risk categories result in increasingly more severe trade restrictions. Imports of animals and meat from negligible risk (RN) regions face few restrictions. Live animals must be inspected, but face no quarantine or testing restrictions. Fresh, chilled, or frozen meat can be imported into the United States with few restrictions. Animals from R1 regions must be certified that they were born and raised in RN or R1 regions and report a negative disease test within 30 days of export to the United States. Fresh, chilled, or frozen meat can be brought into the United States with a similar origin certificate. Animals from regions in higher risk categories face increasingly severe pre-export and post-export quarantines as well as rules on the length of time that the premise where the animal resided has been disease-free and the distance of a disease-free buffer zone around the premise. For meat, rules are added on processing -- removal of bone, blood clots, and lymphoid tissue -- and on storage temperature, length, and pH levels. Meat from R4 and RU regions retains the cooking requirement of the previous legislation.

Introducing the Proposed Rules into a Trade Model

This section modifies a traditional partial equilibrium trade model for beef to reflect the proposed U.S. import rules for FMD. The analysis focuses on beef only, hence assumes that trade in live animals is so small that it can be ignored. Also this assumption means that linkages to other sectors like swine, which are also affected by FMD, are ignored. Beef is assumed to be a homogeneous product, except for the FMD risk which is known by customs officials. Customs officials are able to identify the origin of the beef, but once it clears customs, its national identity is lost. As this is a partial equilibrium model, the prices of other goods and income are exogenous and these factors are not shown in the model presented below to keep the notation simple. All regions are treated as "large" regions in the sense that their actions can potentially affect the world price of beef. Construction of the empirical model will show the validity of this assumption.

The world beef market is divided into six regions. Five regions are net exporters whose behaviors are described by excess supply functions:[2]

(1) $x_i = x_i(p_i)$; $\partial x_i/\partial p_i \geq 0$; $\forall$ i = 1, ..5;

where x_i denotes exports of beef by region i, and p_i denotes the price of beef in region i. The sixth region, the United States, is a net importer. Demand for beef in the United States is given by:

(2) $D_u = D_u(P_u)$; $\partial D_u/\partial P_u \leq 0$;

where D_u denotes U.S. beef demand and P_u denotes the U.S. beef price. Supply of beef in the United States (S_u) depends on the price of beef in the United States and a variable capturing the severity of an FMD outbreak on beef output (α):

(3) $S_u = S_u(P_u, \alpha)$; $\partial S_u/\partial P_u \geq 0$; $\partial S_u/\partial \alpha \leq 0$.

The severity of an FMD outbreak (α) is treated as a random variable with a mean (μ) and a variance (σ^2) which is independent of the level of imports. Beef imports by the United States (M_u) are the difference between demand and supply:

(4) $M_u = D_u - S_u$.

Global market clearing is determined by quantity and price linkages. Imports of beef by the United States must equal exports of beef by the five exporting regions:

(5) $M_u = \sum x_i$.

Although U.S. customs officials know the origin of the beef entering the United States and, hence, its FMD risk, U.S. consumers of beef are assumed to be unaware of the origin of the beef they consume. Thus, beef in the United States has a common price regardless of its origin. Because customs officials can identify the national origin, in the absence of smuggling or arbitrage to avoid import barriers, the United States has the ability to set discriminatory specific barriers to the different exporting regions. The total trade barrier consists of two parts. The first part is a traditional specific tariff (t_i) levied on imports from country i.[3] The second component is a premium based on the FMD risk represented by the exporting region (R_i). This premium is similar to an insurance premium in the sense that it compensates the importing country for the FMD risk it incurs by permitting imports from regions with FMD risk. Thus, the price linkages in the model are:

(6) $p_i = P_u - t_i - R_i\,;\ \forall\ i = 1,..5.$

The five exporting regions correspond to the risk categories in the U.S. proposal. The R4 and RU categories are combined because RU regions face equivalent restrictions to R4 regions and for Foot and Mouth Disease the Animal and Plant Health Inspection Service (APHIS) reports no R4 regions. For each of these categories there is a known constant probability of a single contaminated ton or animal (on a meat basis) crossing the U.S. border. As the quantity of U.S. imports from a particular region with FMD rises, the probability that a contaminated shipment has crossed the border (π_i) rises:

(7) $\pi_i = \pi_i(x_i);\ \partial\pi_i/\partial x_i > 0;\ \forall\ i = 1,..,5.$

The probability that an outbreak occurs in the United States from any source (π) is the cumulative effect of the probabilities from the five exporting regions:

(8) $\pi = \pi(\pi_1, \pi_2, \pi_3, \pi_4, \pi_5)$.

Thus, $(1-\pi)$ is the probability that no outbreak occurs in the United States.

To determine the vector of U.S. barriers levied against the various exporting regions a welfare function for the United States must be established. This model assumes the goal of U.S.

policy is to maximize its welfare plus the tariff and premium revenues less the cost of an FMD control program. Welfare (G) in this partial equilibrium model is defined by consumer's and producer's surplus:

(9) $G(P_u, \alpha) = \int_p^k D_u(P_u)dP_u + \int_o^p S_u(P_u, \alpha)dP_u$.

The tariff and premium revenue (TR) is the sum of the specific tariff and premium levied against each exporting region multiplied by the quantity exported to the United States from that region:

(10) $TR = \sum(t_i + R_i)\, x_i$

and is assumed to be redistributed by the U.S. Government to U.S. consumers. The cost of FMD control depends on the type of program adopted and the severity of the outbreak. The type of program used to control FMD outbreaks is assumed to be exogenously determined by the U.S. Government. Given an outbreak (α), the cost of an FMD control program of type t (C_t) is:

(11) $C_t = C_t(\alpha)$; $\partial C_t/\partial\alpha \geq 0$.

Note that more severe outbreaks, given as an increase in α, result in larger costs. Given the components of expected U.S. welfare, equations (7)-(11), the expected welfare function (W) is:

(12) $W = [1-\pi(\pi_1(x_1),..,\pi_5(x_5))][G_u(P_u)+ \sum(t_i + R_i)x_i\,]$

$+\, \pi(\pi_1(x_1),..,\pi_5)[G_u(P_u, \alpha)+ \sum(t_i + R_i)\, x_i\; -C_t(\alpha)]$.

Maximizing the U.S. welfare and solving for the combination of the tariff and the risk premium facing an individual exporting region i gives:

(13) $t_i + R_i = [x_i/(\partial x_i/\partial p_i)] - \{G_u(P_u, \alpha)]-G_u(P_u)-C_t(\alpha)\}\, (\partial\pi/\partial\pi_i)(\partial\pi_i/\partial x_i)$.

The first term is the standard optimal tariff expression in a partial equilibrium model where the slope of the excess supply determines the tariff (t_i). The second term is an additional premium that consists of the expected welfare change due to an FMD outbreak multiplied by the probabilities of an outbreak being caused by imports from region i. An FMD outbreak results in a loss of meat supplies which raises the price. Consumers experience an unambiguous welfare loss. In the case of producers there is a welfare loss due to the lost output, but a gain due to the higher price. That gain is part of the consumer surplus loss so that the United States as a whole suffers a welfare loss. Thus, $G_u(P_u, \alpha) < G_u(P_u)$. If the probability of a region causing an outbreak is zero as might be the case for an RN region, then no premium on the tariff is needed. As the probability of a region causing an outbreak rises so does the premium. Thus, regions with greater risks face larger total barriers. The larger barriers force those regions down their excess supply functions, and therefore, shifts the mix of imports away from the more risky regions.

Empirical Model

The empirical model uses the risk classification initially proposed by APHIS to categorize regions. In that classification there are no R4 regions and only Greece and Italy, which are net beef importers, are in the R3 category. The behavioral equations are assumed to be linear and the elasticities used to calibrate the equations to the 1994-1996 base period are from the Static World Policy Simulation (SWOPSIM) model used by the U.S. Department of Agriculture to evaluate the impacts of the Uruguay Round (Sullivan, Wainio, and Roningen, 1989). To determine the slopes and constants for the linear equations, world beef trade is divided into two types of beef. The "clean" market consists of the United States and RN regions and the model assumes a price of \$2,000 per ton for those regions. The other type of beef is "infected" beef traded by R1-RU regions and the model assumes that excess supply of "infected" beef to the United States equals zero with a price of \$1,500 per ton.

As shown by equation (13) the other key components to determine the welfare optimizing barriers facing each exporting region are the risk associated with imports of beef from each region, the expected loss in welfare if an FMD outbreak occurs, and the cost of the control program. The probabilities of FMD appearing in livestock herds are given for each risk category by APHIS and range from one out of one million animal units to one out of one hundred animal units. In addition, an adjustment must be made for the risk that the commodity remains infected after storage, handling, and processing for export -- what APHIS terms the commodity risk. In a general numerical example, APHIS uses a commodity risk of one out of one million. The proposed rules do not give specific commodity risks. Because cooking can destroy FMD and cooked beef may already be imported from regions with FMD, the situation considered here is concerned with fresh beef. While removal of lymphoids and deboning lowers the commodity risk of fresh beef, without additional information a commodity risk of one is used in this study. This means that beef is assumed to be infected with a probability equal to that of FMD appearing in the herd and these risks are used for the term $(\partial\pi_i/\partial x_i)$ in each equation (13). As a result of this assumption the premia found in the numerical results are overstated because they ignore steps that reduce the risk of FMD transmission.[4] This model also assumes that the probability of an outbreak in the United States is the sum of the probabilities of obtaining FMD from each risk category, or $(\partial\pi/\partial\pi_i) = 1$.

The second component is the expected loss in U.S. welfare in the event of an outbreak. In this analysis, the scenarios for alternative outbreak patterns over a 15 year period developed by Aulaqi and Sundquist (1979) are used. They consider three alternative FMD control strategies. When FMD is assumed to be endemic with no public control, FMD epidemics affecting 40-75 percent of susceptible livestock occur every 5 to 10 years. Thus, for their 15 year period, they experience 3 epidemics with the first outbreak being the most severe. Between these epidemics the infection rate drops below 1 percent. Over the 15 year period the average infection rate is 6.3 percent. If a compulsory vaccination program is introduced following the introduction of FMD, Aulaqi and Sundquist (1979) report an average infection rate of 0.2 percent. The third scenario is eradication where animals are quarantined and slaughtered following an outbreak until the disease is eliminated. Based on the British experience with an FMD outbreak in 1966 and 1967, Aulaqi and Sundquist estimate that about 1 percent of U.S. livestock would be lost.

While FMD is not always fatal to livestock nor generally infectious to humans, this analysis assumes that all livestock stricken with FMD are destroyed and their meat is not marketed. To find the decline in U.S. beef output, the average U.S. cattle and calf inventory for the base period, 1994-1996, or 103.22 million head, is multiplied by the assumed losses of 6.3, 0.2, and 1.0 percent. These animals are converted to beef lost by multiplying by the ratio of beef production to animals slaughtered in the base period. The resulting beef output losses are : 2.114 million tons under the endemic scenario; 0.0671 million tons under the compulsory vaccination program, and 0.3355 million tons under the eradication program.

The final term to determine in equation (13) is the cost of the different types of control programs. In all three cases, beef producers are assumed compensated for the livestock lost as the producer surplus loss is assumed paid by taxpayers. For the policy of eradication additional administrative and operating costs are incurred. Aulaqi and Sundquist analyzed these costs for the late 1970s. Inflating their costs figures to 1996 price gives administrative and operating costs of $ 500 million. Under the vaccination policy, the vaccine costs between $0.30 and $0.60 per animal with an additional $0.20 per vaccination to administer the vaccine. To be effective at least 90 percent of the herd must be vaccinated twice per year. In this analysis, the higher figure is used. Given the base herd size these figures translate into annual vaccination costs of $ 165.15 million.

Model Results

The specific tariffs and premia by risk category are shown in table 1.[5] The first column gives the welfare optimizing tariffs when there is no expected output loss due to FMD and no risk of obtaining FMD through imports -- the No FMD scenario.[6,7] For each FMD outbreak and control scenario two sets of results are presented. The no risk case is the vector of tariffs (t_i) when the expected output loss due to FMD is recognized in setting the tariff, but the import risk -- the second term of equation (13) -- is not included. These tariffs are higher than the No FMD tariffs because the output loss raises U.S. beef imports and hence the term ($x_i/(\partial x_i/\partial p_i)$) rises. The second set of results for each scenario are the premia which incorporate the FMD risk by region.

As noted, because imports are expected to trigger outbreaks and a fall in U.S. beef supply, even when the risk is not directly incorporated into the tariff setting, the tariffs rise as expected imports rise. The uniformity of the tariffs levied across the regions is imposed on the model solution for two reasons. First, in the absence of any FMD risk, the World Trade Organization (WTO) non-discrimination rule applies. Second, if price discrimination based on each region's excess supply elasticity is allowed, the effects of pure price discrimination and the differences due to risk could be confused.[8]

Including the import risk and the associated expected loss in national welfare further adds to the total barrier. For the region classified as negligible risk (RN), the premia are small, ranging from \$3.81 per ton under the endemic scenario to \$0.22 per ton under the vaccination program. As FMD risk increases, the premia rise in proportion to the increased probability of importing FMDby region. Thus, in the endemic scenario the premium for RN regions is \$3.81 per ton, but it is \$38.09 per ton for R1 regions as the risk increases from 1 in one-million to 1 in 100,000.

With calibration of the model so that beef is not supplied to the United States by any region at a price below \$1500 per ton, several of the barriers are prohibitive. For each FMD control scenario the total barrier levied against R4/RU regions is prohibitive regardless of the U.S. control strategy and these regions do not supply the U.S. market. For the R2 classification, the total barriers under the endemic and quarantine-slaughter scenarios of \$ 498.35 and \$ 186.98 per ton are also prohibitive because the U.S. price less the barrier is below \$ 1500 per ton. The barrier on R2 regions under the vaccination scenario of \$ 100.72 per ton allows that region to supply 96 thousand tons. Thus, only negligible and slight risk regions are consistent suppliers of beef to the United States.

The above results use the 15-year average loss found by Aulaqi and Sundquist as the expected loss, but as they show, catastrophic losses in individual years occur. Table 2 shows the premia under the endemic scenario when the expected loss from FMD used to set the premia is catastrophic. The catastrophic loss of 30 percent is compared to the 6.3 percent loss used in the earlier analysis. For regions in the negligible risk category, the premium due to an increase in the FMD loss from 6.3 to 30 percent rises from \$ 3.81 per ton to \$ 20.96 per ton while the premium on R1 regions rises from \$ 38.09 per ton to \$ 209.59 per ton. Even with the large total barriers -- \$ 289.09 per ton for RN regions and \$ 477.72 per ton for R1 regions -- given the catastrophic loss (30 percent), the United States imports large quantities of beef to compensate for the large output lost to the FMD outbreak. Of that beef, only 3.2 percent is imported from R1 countries.

The extent to which the type of control strategy affects the total barrier given a common expected output loss of 6.3 percent is given in table 3 for RN, R1, and R2 regions. These results show that for the same expected output loss the type of control strategy has little effect on the barriers. Under the endemic or no control program, the RN region's barrier is $ 121.22 per ton. The barrier rises to $121.38 per ton under the vaccination program, and rises a bit more to $121.72 per ton with the quarantine-slaughter policy. A similar pattern occurs for the higher risk categories, but larger steps result from the increased risk. Yet, the increases are not large across the different control programs. For R1 regions, the largest difference is $5 per ton. For R2 regions, which are not supplying the United States in this scenario, the largest step is $50 per ton.

The point of adopting a control program is to reduce the expected severity of the output drop. That effect is captured in tables 1 and 3 where the total barriers for the RN, R1, and R2 regions in the quarantine-slaughter and vaccination scenarios are noticeably lower than those under the no control scenario and closer to the levels of the No FMD scenario. An issue is whether the additional costs of the quarantine-slaughter and vaccination programs are returned by reducing the expected output losses and the consequent expected loss in welfare. The expected social loss in the endemic scenario compared to the NO FMD scenario is $3.8 billion. The quarantine-slaughter policy costs $500 million dollars, but reduces the expected output loss from 6.3 percent to 1 percent. The expected social loss due to FMD in this case, including the $500 million program cost, is $1.0 billion. Thus, by spending $500 million, given these estimates there is a $2.8 billion reduction in social cost. The vaccination program further reduces the expected loss and social cost -- down to $281 million. However, unlike the quarantine-slaughter policy which is only used when an outbreak occurs, the vaccination program costs are incurred each year. Given the cost estimates used in this analysis, if outbreaks occur less than every 3.3 years the vaccination cost is lower than the quarantine-slaughter policy. If outbreaks occur less frequently, the quarantine-slaughter policy is less expensive.

Conclusions

This paper expends research linking trade barriers to the health risk represented by imports by developing a model for beef trade that captures proposed U.S. import rules for beef. Those rules recognize multiple supplying regions, each with a different risk of causing an FMD outbreak in the United States. The model assumes that trade barriers are set to maximize expected welfare given the probability that FMD will be imported. The resulting barriers consist of two terms. One term is the standard optimal tariff facing each exporter. The second term is a premium which recognizes the probability that FMD will be contained in the exporter's beef and the expected loss in U.S. welfare if an FMD outbreak occurs.

The empirical model classifies regions into risk categories based of the system proposed by the United States. There are four possible suppliers of beef to the United States and three possible FMD control strategies where each control strategy has a different expected output loss and cost. The results show that the premia set are sensitive to the expected output losses and to the risk represented by each category. The premia rise as the expected output loss rises. The total barriers -- tariffs and premia -- levied against high and unknown risk regions (R4/RU) are prohibitive regardless of the type of control program adopted. Under the endemic and quarantine-slaughter policy even the low risk (R2) category faces prohibitive barriers given the assumptions of the empirical model. However, the vaccination policy lowers the expected social loss from an FMD outbreak enough to allow R2 regions to export to the United States.

A scenario where the outbreak loss is expected to be catastrophic sharply increases the premia, but continues to allow RN and R1 regions access to the U.S. market to replace lost U.S. beef production. Virtually all of the beef imports originate in RN countries.

The estimated barriers are not very sensitive to the control program when the expected loss is held constant, rather it is the reduction in the expected losses due to the control program that drives the barrier levels. The results also suggest that of the three control programs evaluated, those that reduce the frequency and the severity of FMD outbreaks are worth the additional costs incurred.

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Footnotes

[1] The United States drafted and circulated for comment its proposed changes to U.S. import rules for meat and livestock (USDA/APHIS, 1996). Following a period of comment revised rules have been developed. At the time of this research, the revised rules were not yet public so the model follows the initial proposal. The most likely change is in the regionalization which in the initial proposal follows a national system.

[2] Becuase the R4 and RU regions are treated equivalently in the regulations, they are aggregated into a single region. Thus, there are five exporting regions instead of six.

[3] Unlike existing WTO rules the tariffs are allowed to be discriminatory to fully separate the exercise of market power from the recognition of FMD risk.

[4] The extent of over statement can be quite large. If the commodity risk used in the APHIS example is inserted into equation (13), the risk premia effectively vanish.

[5] Both countries assigned to the R3 region are importers. In this homogeneous good model they do not supply the United States and barriers are not reported in the tables.

[6] The prices and quantities in the NO FMD scenario differ from those in the 1994-1996 base because the base data recognize an FMD risk and prohibit imports from non-RN regions.

[7] The tariffs found are roughly 5 percent which is below the 31 percent Uruguay Round commitment (Ingco, 1994).

[8] An example of this confusion between policy instruments can be found in the paper by Krutilla (1991) where an environmental tax substitutes for the failure of the country to use an optimal tariff.

Table 1: Beef Tariffs and Risk Premia by Risk Category and Control Program[1]

Region	No FMD	Endemic		Quarantine-Slaughter		Vaccination	
Risk	tariff	tariff	premia	tariff	premia	tariff	premia
			-- dollars per ton ---				
RN	77.34	117.41	3.81	83.70	1.03	78.61	0.22
R1	77.34	117.41	38.09	83.70	10.33	78.61	2.21
R2	77.34	117.41	380.94[2]	83.70	103.28[2]	78.61	22.11
R4	77.34	117.41	38094.00[2]	83.70	10327.87[2]	78.61	2210.87[2]

[1] R3 countries are net importers of beef so no excess supply by R3 countries to the United States is allowed.

[2] Prohibitive tariffs as no exports to the United States for prices below $1500 per ton.

Table 2: FMD Premia with Base and Catastrophic Losses under an Endemic (No Control) Scenario[1]

Region	Percent Decline in Beef Output:	
	6.3	30
	-- dollars per ton --	
RN	3.81	20.96
R1	38.09	209.59
R2	380.94	2095.88

[1]Because the R4/RU region faces prohibitive barriers in all scenarios, the results are not reported.

Table 3: Total barriers under Alternative Control Strategies with a Constant Expected Output Loss of 6.3 Percent[1]

Region	No Control	Quarantine Slaughter	Vaccination
		-- dollars per ton --	
RN	121.22	121.72	121.38
R1	155.50	160.50	157.15
R2	498.35	548.35	514.86

[1] Because the R4/RU region faces prohibitive barriers in all scenarios, the results are not reported.