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PRRS and the North American Swine Trade: A Trade Barrier Analysis

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ABSTRACT

The partial equilibrium model links the infection risk from imported products to a premium, which compensates the importing country for the risk incurred by allowing imports from infected countries. The model is applied to the Porcine Reproductive and Respiratory Syndrome (PRRS) and Mexican live swine imports. The premium is sensitive to the expected loss from a PRRS outbreak and to the magnitude of the risk. As the risk or severity of PRRS rises, so does the level of the barrier. If swine imports are categorized and appropriate restrictions applied, an acceptable level of disease protection can be achieved while improving national welfare.

Key Words: *livestock health risk, PRRS, trade barriers.*

All countries maintain health and sanitary regulations on imported products to protect the health of consumers and interests of producers. Article XX of the World Trade Organization (WTO) agreement confirms the fundamental right of nations to set sanitary and phytosanitary (SPS) import barriers on agricultural goods to protect "human, animal, or plant life or health," as long as the measures are not disguised trade barriers. The Uruguay Round Agreement strengthened SPS rules by requiring that SPS barriers be based on science and that nations use an acceptable risk criterion (Roberts and DeRemer). Nevertheless, it is difficult to determine whether a regulation is being properly applied or is a disguised trade barrier.

This study focuses on the setting of trade barriers that reflect the disease risk associated with imports. A barrier based on risk may not be a prohibitive barrier. If the actual barrier is prohibitive a nation can capture additional gains from liberalizing trade while still protecting the health of domestic plants and animals. In 1994, Mexico created a barrier to mitigate the risk of the Porcine Reproductive and Respiratory Syndrome (PRRS) virus entering through imports of live swine, which, along with the Mexican economic problems, severely reduced trade. From 1991–1993, prior to the barrier, U.S. exports of live swine to Mexico averaged 127,000 head. In 1995, U.S. exports of live swine to Mexico fell to 4,900 head and recovered to 40,600 head in 1996. Swine trade after 1996 has grown, but the levels of Mexican swine imports observed before the barrier have not been repeated. This analysis investigates whether the Mexican trade barrier accurately reflects the PRRS health risk, using a framework that links trade barriers to the disease risk and potential production losses that an importer faces when allowing imports from infected countries.

The first section introduces the nature of

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the PRRS disease and explains the Mexican import policy that is designed to eliminate the possibility of PRRS introduction through imports. Following the description of the disease and policy environment is a brief description of the partial equilibrium model that is used to examine this issue. The model shows how the level of the premium is linked to the magnitude of the risk and the scope of the expected welfare losses. The welfare maximizing level of the premium is determined given the expected PRRS-related production losses, the risk of contracting PRRS from imported swine, and trade elasticities. The results from the model show that the premium is sensitive to the expected loss in Mexico due to a PRRS outbreak and to the magnitude of the risk. The results show that an alternative policy choice could give Mexico higher levels of welfare, while maintaining an acceptable level of disease risk.

Porcine Reproductive and Respiratory Syndrome and Mexican Import Policy

The PRRS virus is highly contagious and affects swine in all stages of development. The disease is characterized by late-term abortions, stillbirths, piglets born weak, and respiratory difficulties in pigs of all ages. Classic PRRS features are disguised symptoms and enhancement of pre-existing diseases in the pig. Although PRRS is sometimes fatal to young pigs, the main economic losses are from a lower reproductive rate in sows and increased finishing times in slaughter hogs. PRRS is mostly transmitted by direct bodily contact, but to a lesser degree by semen and waste. To this point, the PRRS virus has not been shown to be transmittable through meat, as it is sensitive to heat and is short-lived. Thus, live animals are the primary source of transmission.

In 1994, Mexico enacted a SPS barrier designed to stop the introduction of PRRS from imported swine. The barrier was a response to outbreaks of new strains in several major exporters of swine, but mainly in its largest supplier, the United States. Live swine imported into Mexico must comply with several regulations before entering the country. Initially, exporting U.S. herds must have a health certificate issued by an Animal and Plant Health and Inspection Service (APHIS) veterinarian. To be classified negative for PRRS the entire herd from which the animals are being exported must be free of PRRS during marketing and at the time the export-bound animals are grouped for shipment (Export Requirements Summary). Additionally, no swine can be introduced into the exporting herd from herds where PRRS has been identified within 30 days prior to the issuance of the health certificate. Therefore, the exporting herd plus any herd that supplies pigs to that herd must test PRRS-negative 30 days before shipment. Before crossing the border the animals are unloaded and re-inspected for clinical signs of PRRS. Slaughter hogs must be transported to a federally inspected and certified TIF slaughter plant, where a Mexican federal veterinarian monitors unloading. Breeding and feeder pigs are transported in sealed trucks to their destination, where they are subject to a 30-day quarantine.

Literature Review

Literature that relates to the PRRS issue comes from a wide body of research that ranges from examining the physical and production effects of a disease to trade policy. This research combines the modeling of animal health issues and analysis of Sanitary and Phtyosanitary (SPS) barriers to trade. At one end of the spectrum are the disease modeling studies that dominate the veterinary science literature (Rodriques and Gardner; Gardner and Carpenter). Such studies examine farm-level decision making and financial evaluation of disease-mitigation methods, but do not incorporate domestic or foreign policy situations. A number of studies in the agricultural trade literature (Hillman, 1978 and 1991, Ndayisenga and Kinsey, and Orden and Roberts) describe trade barriers and the motivations behind their creation, but do not quantify the impact of the barriers nor examine the specific disease factors involved in the origins of the regulations.

Integrating the economic consequences of the disease, the impacts of risk, and trade policy is the focus of studies by Dijkhuizen and Renkema; Rendleman and Spinelli; Berentsen and Dijkhuizen; Krissoff, Calvin, and Gray; Orden and Romano; and Paarlberg and Lee. These studies commonly use some form of cost-benefit analysis to examine different policy environments and outbreaks of the disease. Another key feature of the models is the development of epidemiological and economic sub-models. The epidemiological model identifies the transmission of the disease throughout a population and production consequences, while the economic model captures the losses and benefits of control strategies and import policies. Dijkhuizen and Renkema and Berentsen and Dijkhuizen use this method to examine Foot-and-Mouth Disease in the Netherlands. Rendleman and Spinelli use a partial-equilibrium model of the U.S. hog and pork sector to examine methods of African Swine Fever prevention. Krissoff, Calvin, and Gray estimate the extra protection Japan imposes on apple trade and the economic effects of liberalization. Orden and Romano balance the trade gains from opening the U.S. avocado market with the potential losses due to disease. Paarlberg and Lee take a different approach to the issue by creating an optimal tariff that recognizes the gains from trade for an importing country as well as the potential cost of outbreaks, control costs, and risk of an outbreak.

A Partial-Equilibrium Framework Incorporating Animal Disease and Import Policy

One limitation of the previous literature is the absence of research into the effects of the PRRS on a national scale or on trade, specifically the North American swine trade. Current economic analysis of the PRRS virus does not investigate issues beyond farm-level decision making. This study attempts to fill that gap by examining the welfare impacts of current and potential Mexican swine trade policies. It allows for not only the welfare losses due to the disease, but also the welfare loss due to restrictive policies designed to protect against the initial infection using a partial equilibrium model, modified to reflect the trade and regulatory conditions of the Mexican swine market.

The model description begins with the formulation of the market relationships in Mexico. In this partial equilibrium model, the prices of other goods and income are exogenous and these factors are not shown in the model to keep the presentation clean. Trade in pork or other products is not incorporated into the model. This assumption does not affect the disease transmission in the model because PRRS directly affects only live swine and transmission via pork has not been demonstrated. Confining the analysis to live swine greatly simplifies the barrier setting and regional structure of the model, but does so by ignoring potential large price effects on pork, beef, and feed inputs.[1]

Live swine trade is largely regional rather than global because of the difficulties in shipping live animals. The exporting countries are limited to the United States and Canada where Canada exports to the United States which exports swine to Mexico.[2] Due to relatively low U.S. import barriers for swine trade and similar PRRS status, the United States and Canada are taken as a single net exporting region (US/CAN) described by an excess supply function:

$$(1) \quad x_u = x_u(p_u); \qquad \partial x_u/\partial p_u \geq 0.$$

The x_u denotes exports of swine by the US/CAN region, and p_u denotes the price of live swine in US/CAN.

The second country, Mexico, is a net importer. Demand from Mexico for live swine is

[1] In this model, the impacts of alternative policies for live swine appear as swine price changes, mostly in Mexico. The assumption is that surplus measured as the area under the demand function for swine is a measure of the benefit to consumers of pork. This is similar to evaluating the impacts of a wheat policy change using the derived demand for wheat instead of the final demand for wheat products. Impacts on feedstuff prices are ignored. The consequences of this assumption depend on the linkage of Mexico to world feedstuff prices and the extent to which Mexican behavior affects world feedstuff markets.

[2] If pork or feedstuffs were included, a full global pork/feedstuff model would be required to accurately incorporate the price determination.

a straightforward non-positive function of price shown by:

$$(2)\quad D_m = D_m(P_m); \qquad \partial D_m/\partial P_m \leq 0,$$

where D_m is the Mexican demand for live swine and P_m is the Mexican price for live swine. The supply of swine for Mexico (S_m) is a non-negative function of the price of swine in Mexico. An additional variable is included to capture the severity of a PRRS outbreak on production (α):

$$(3)\quad S_m = S_m(P_m, \alpha); \qquad \partial S_m/\partial P_m \geq 0; \qquad \partial S_m/\partial \alpha \leq 0.$$

The severity of the outbreak (α) is treated as a random variable with mean (μ) and a variance (σ^2) and is independent of the level of imports from the United States and Canada. Live swine imports for Mexico (M_m) is the difference between the supply and demand of live swine:

$$(4)\quad M_m = D_m - S_m.$$

Swine are assumed to be a homogenous product, except for the PRRS risk. It is assumed that all of the animals are tagged and these markings specify their place of origin and allow authorities to track the animals to their correct destination. Though the customs officials are able to identify the country of origin of the swine and its respective PRRS risk, the producers of swine in Mexico are unsure of the risk that imported swine bring. Therefore, live swine in Mexico have a common price, regardless of the country of origin.

The total barrier that the US/CAN faces is the sum of two parts. The first part of the barrier is a traditional specific tariff, t_u, set by Mexico within the specified limits of NAFTA. The second part of the barrier is a premium (R_u) that is based on the risk that PRRS from US/CAN poses to Mexico's swine herd. This premium compensates Mexico for the PRRS risk that it incurs by permitting imports from the United States and Canada, which is the infected region. The price linkage for the barrier is:

$$(5)\quad p_u = P_m - t_u - R_u$$

As the quantity of live swine crossing the Mexican border rises, the probability of an outbreak occurring in the Mexican herd rises. The risk of an outbreak (π) is a known probability of a single contaminated animal crossing the border and transmitting the disease:

$$(6)\quad \pi = \pi(x_u); \qquad \partial\pi/\partial x_u > 0.$$

A welfare function is used in order to determine the Mexican barrier to be levied. The model assumes the goal of Mexican official policy is to maximize national welfare plus the tariff and premium revenues (Paarlberg and Lee). The welfare of private agents (G) in the partial equilibrium model is defined by consumer and producer surplus:

$$(7)\quad G(P_m, \alpha) = \int_p^k D_m(P_m)\,dP_m + \int_o^p S_m(P_m, \alpha)\,dP_m.$$

The total revenue (TR) is the sum of the specific tariff and the premium levied against US/CAN multiplied by the quantity exported to Mexico from US/CAN:

$$(8)\quad TR = (t_u + R_u)\,x_u.$$

This is assumed to be redistributed by the Mexican government to Mexican producers and consumers. Thus, the expected welfare function (W) is:

$$(9)\quad W = [1 - \pi(x_u)][G_m(P_m) + (t_u + R_u)x_u] + \pi(x_u)[G_m(P_m, \alpha) + (t_u + R_u)x_u].$$

Maximizing the expected Mexican welfare and solving for the risk premium gives:

$$(10)\quad R_u = -\{G_m(P_m, \alpha) - G_m(P_m)\}(\partial\pi/\partial x_u).$$

The premium consists of the expected welfare decrease due to a PRRS outbreak multiplied by the probability of an outbreak occurring because of an individual imported animal transmitting PRRS. An outbreak of PRRS in Mexico results in a decline in the number of marketed hogs each year by domestic producers, but this causes a rise in price, which benefits producers. It is an empirical issue whether the gain to producers from higher prices exceeds or is less than the value of lost production. Orden and Romano show a net gain to producers is possible. Consumers experience a welfare loss due to the rise in prices. While R_u is strictly ambiguous, the most plausible result is a national loss in welfare, where $G_m(P_m, \alpha) < G_m(P_m)$. From equation (10), as the welfare loss under a PRRS outbreak increases the premium rises. Furthermore, if the probability of an outbreak increases, so does the premium.

Empirical Trade Model of the Swine Market With PRRS

The model presented in the previous section incorporates the risk of contracting PRRS from imported swine in a situation where the importer maximizes total expected national welfare with a premium compensating for the risk they incur by allowing imports from infected countries. This section builds the numerical groundwork for the execution of the conceptual model. The key parameters that are needed for the model are the estimated losses due to introduction of the PRRS virus into Mexico, import policy options open to Mexico, and basic data to create the supply and demand equations in the model.

For each policy option, three disease loss possibilities are developed to model a PRRS epidemic in the Mexican swine herd resulting from the introduction of the PRRS virus from an outside source. The length of an outbreak is estimated from past patterns exhibited by PRRS in the United States. Since the discovery of the disease in the late 1980s, there have been two nationwide outbreaks of PRRS in the United States. Before each national outbreak there was a period of one to two years where the disease spread throughout the country. The primary, most severe part of the outbreak lasted an average of three years. Following this three-year period, immunity develops to that strain and there is a two-year period of decline. After that, though PRRS is no longer a serious threat, it remains, causing very minor losses in conjunction with other diseases. To incorporate two complete outbreaks (cycles) of the disease, the average yearly loss was based on a 15-year period.

The production loss possibilities are based on the most recent published results about the prevalence of PRRS in the United States (Hurd; Rothenberger). PRRS raises the rates of abortions, farrowing death, pre-weaning death, and finishing time by 10 percent, 13.5 percent, 10.6 percent, and 21 days respectively (Rothenberger; National Animal Health Monitoring Service (NAHMS)). To determine the loss in output at a national level, two separate "national" herds are formed. One herd is assumed PRRS free, thus experiencing a normal production efficiency. The other herd experiences a PRRS outbreak using the data by Rothenberger and by NAHMS. Final production results show that PRRS causes a 7.2-percent reduction in the number of pigs reaching the finishing stage and a 5.8-percent drop in the number of slaughter swine marketed in a particular year due to increased finishing times. A total decline of 13 percent in the number of marketed swine characterizes PRRS effects during the height of an outbreak, which would be the maximum yearly loss if Mexico were to become infected. Therefore, incorporating the peak 13-percent production decrease into the disease cycle, the average yearly production loss for Mexico would be 6.3 percent (780,000 head) called the *Medium Loss possibility.* Furthermore, High Loss (13% production decline or 1.6 million head) and Low Loss (2.4% production decline or 300,000 head) possibilities are developed to encompass the spectrum of possible epidemic situations.

In addition to the range of disease possibilities, the Mexican government could take many different policy responses toward the PRRS threat. For this analysis, several policy options are considered with each having a different risk of PRRS transmission. One policy option is the current policy described earlier. Other options involve whether a PRRS test is required before export and whether animals are categorized by end use with different uses subject to different PRRS barriers. The PRRS test is effective at screening infected animals and so alters the likelihood of disease transmission. Categorizing animals by end use also alters the risk of transmission to the Mexican herd. Animals for breeding and feeding represent a higher risk of transmission than animals for immediate slaughter. For each policy option, two levels of transmission risk (scenarios) are considered—a high-risk situation and a low-risk scenario.

A short description illustrates how the transmission risks are calculated. Two separate risks are included. One risk is that the animal is infected. This risk is set at 54.8 percent for slaughter hogs and 31.3 percent for feeder and breeder pigs (Rothenberger). The other risk is that an infected animal transmits the disease once inside Mexico, a commodity risk. It is assumed that once one native animal or herd is infected, the virus is transmitted throughout the entire Mexican swine herd and it is too late for an effective Mexican control policy. The assumed commodity risk for slaughter hogs for the low-transmission-risk situation is one in one million or one in one hundred thousand in the high-transmission case. Breeding and feeder pigs have a commodity risk of 1 because these animals come into contact with the Mexican herd and the nature of the disease allows for the possibility that PRRS can be dormant for the holding period, spread among the quarantined animals, or spread from a holding pen.

The Restrictive Policy represents the current policy of the Mexican Government and the probability of an outbreak of PRRS in Mexico under this policy is zero. It is used as a point of comparison because the Restrictive Policy plus the existing 20-percent tariff is the original market condition. Since many in the United States suspect that Mexico is already infected with PRRS, a Pre-existing Infection scenario considers policy where Mexico like the United States and Canada is infected with the PRRS virus. Thus, there is no barrier in the market due to PRRS.

The first proposed PRRS mitigation policy, Slaughter Pig Testing, allows slaughter swine into Mexico with one test for PRRS, only in those animals being exported. This is a departure from the Restrictive Policy, where the entire exporting herd and sourcing herds are tested. Exporters are responsible for the cost of the testing.[3] The testing cost is the per-hog cost of the IDEXX Laboratories PRRS antibody test. The IDEXX Laboratories Herd-Check PRRS test is an industry standard with a 99.7-percent accuracy rating and a cost of $1.22 per animal. There is not any mandated Mexican federal licensing of slaughtering plants and the trucks transporting the hogs could unload at any slaughtering facility as long as the hogs remain isolated from the Mexican herd. Breeder and feeder pigs would remain under the same restrictions as the Restrictive Policy. To calculate the final transmission risk the infection rate of the slaughter animals (0.548) is multiplied by the failure rate of the test, 0.005. Their product is the chance that an individual slaughter hog is infected with PRRS, the test fails, and the hog can transmit the disease. This number is then multiplied by the commodity risk corresponding to the low- and high-transmission scenarios. The result is the probability that an individual slaughter hog, infected with PRRS, where the test failed, will come into contact with a Mexican herd and transmit the virus. Under Slaughter Pigs Testing—Low Transmission and Slaughter Pigs Testing—High Transmission, the probability that any one pig will be infected and transmit the PRRS virus to Mexico is 1 in 364 million and 1 in 36 million, respectively.

Another policy option, Slaughter Pig No Testing, allows slaughter swine into Mexico without any testing for PRRS. The remaining regulations would be the same as the Slaughter Pig Testing policy and there are the same two

[3] The premia found and reported reflect the effect of the PRRS test on the probability, but do not include the cost of the PRRS test. Consequently, the total barrier faced by exporters is the tariff, the premium, and the PRRS test, if required. The tariff revenue and the premium revenue accrue to Mexico while the cost of the PRRS test is paid by swine producers in the exporter.

alternative commodity risks. Under the Slaughter Pig No Testing option, the probability that any one hog will spread the PRRS virus to Mexico is 1 in two million in the low-transmission-risk scenario and 1 in 200,000 in the high-risk scenario. The higher probabilities of transmission reflect the absence of the PRRS test.

The next set of policy options, All Pigs Testing and All Pigs No Testing, treat breeding, feeder, and slaughter pigs as a single category. All Pigs Testing allows the importation of any animal which tested negative for PRRS one time without any additional regulatory requirements. In this case, the low commodity risk is used for slaughter hogs, while breeding and feeder pigs are assumed to have a commodity risk of 1. Under the All Pigs Testing policy option, the probability that any one animal will spread the PRRS virus to Mexico is 1 in 27,000. The last possible step that Mexican authorities could take is to allow the importation of any animals regardless of its PRRS status and without testing. Under the All Pigs No Testing policy, the probability that any one imported animal will spread the PRRS virus to Mexico is 1 in 80. The much higher risk in the last two scenarios reflects the high risk of breeding and feeder pigs.

The numerical specification of the model's supply and demand relationships use a three-year average, 1992–1994, to account for the variability in the Mexican market and imports from the United States. The Food and Agriculture Organization (FAO) FAOSTAT agriculture database supplied the information about the Mexican and Canadian markets, while the Economic Research Service's *Livestock, Dairy, and Poultry Outlook* supplied the data for the United States. Since the United States and Canada are treated as a single exporting region, they have one common elasticity of demand and supply, −0.86 and 1.2 (Sullivan, Wainio, and Roningen). The elasticities of demand and supply used for Mexico are −3.0 and 0.55 (Sullivan, Wainio, and Roningen; Gardiner, Roningen, and Liu). Because these elasticities apply to pork, sensitivity analysis on their values is performed to determine whether different values alter the conclusions.

The Mexican PRRS barrier, as described in the Restrictive Policy, is associated with an added cost to the exporter because of the testing requirements. The compliance cost of the PRRS testing is a significant part of the nontariff barrier that exists in this market. To calculate the real cost of U.S. swine entering Mexico, a tariff equivalent is calculated that restricts trade to the same extent as the regulatory protection (Josling; Krissoff, Calvin, and Gray). The slaughter hog price in Omaha is used as the base U.S. price. The transportation cost from Omaha to Mexico is then added to the hog price, plus a constant 20-percent *ad valorem* tariff.[4] The transportation cost (per mile) for shipping hogs in the United States is from an independent transportation company in Jefferson City, Missouri. This total is subtracted from the Mexican producer price for slaughter hogs to get the estimated cost of the PRRS compliance. The cost of complying with the PRRS health requirements is estimated to be $12.95 per hog, or about 13 percent of the value. The real total trade barrier seen by exporters is estimated at 33 percent.

Results

The results allow Mexico to set a two-part import barrier against swine from the United States and Canada consisting of a fixed 20-percent *ad valorem* tariff, plus a premium that balances social welfare against the expected risk of a PRRS outbreak. The situation simulates an environment where Mexico adds a risk-based premium, rather than a disguised nontariff barrier, to the existing 20-percent tariff barrier to manage the threat of PRRS. Initially, the original market conditions (20% tariff plus Restrictive Policy—a 33% real-trade barrier) are compared to only a 20-percent tariff. Thereafter, the alternative policies to man-

[4] The need to include the transportation cost arose because Mexico has a barrier due to PRRS regulations in effect. The presence of the PRRS regulations precluded using the Mexican price less the *ad valorem* to determine the border price.

Table 1. Mexican Premia for Imported Swine by Policy Option and Disease Scenario

Policy Option	Disease Scenario: Low Loss	Medium Loss	High Loss
	Dollars Per Animal		
Pre-Existing Infection	0	0	0
Slaughter Pig Testing			
Low Transmission	1.32	1.40	1.50
High Transmission	2.02	3.30	3.80
Slaughter Pig No Testing			
Low Transmission	15*	40*	50*
High Transmission	150*	400*	500*
All Pigs Testing	3,000*	3,000*	3,500*
All Pigs No Testing	300,000*	1,000,000*	1,000,000*

* Note: These policy option/disease scenarios are trade prohibitive.

age the PRRS risk are introduced. When the 33-percent total tariff barrier falls to a flat 20-percent barrier, Mexican welfare increases by $138 million as a result of increased trade. On a base swine herd of 11 million head, imports by Mexico jump from 132,000 to 3.9 million head as the total import barrier decreases. It is in this more liberal trade environment that the policy options and disease scenarios are incorporated.

For each PRRS disease and policy scenario, two results are shown: the tariff and the premia. The rows of Table 1 describe the policy options, while the columns are the premium under each disease scenario. A fixed 20-percent tariff, $20.80 per hog, does not change in any of the disease scenarios or policy options. The sum of the tariff, the premium, and the PRRS test, if required, is the total barrier faced by exporters. Moving from one policy down to the next, the PRRS restrictions become less stringent and the likelihood one imported animal will cause an outbreak increases.

The first row of Table 1 describes a situation where there is a pre-existing PRRS infection, which carries no additional PRRS risk from imports. Mexico is infected with PRRS and maintains only its 20-percent tariff. The probability of transmission via imports is set at zero; therefore the premia under this policy are zero for all disease scenarios. This situation allows the analysis to focus on the consequences of including only the production loss in the model. The increase in Mexican imports in each disease outbreak possibility of the pre-existing infection situation roughly corresponds to the production loss Mexico experiences due to the PRRS outbreak. The welfare gains shown in Table 2 are a comparison of the Pre-existing Infection policy, a 20-percent tariff, versus the 33-percent tariff of the

Table 2. Changes in Mexican Welfare[1]

Scenario	No PRRS	Low Loss	Medium Loss	High Loss
	Million Dollars			
20% Tariff	138	NA[2]	NA[2]	NA[2]
Pre-existing Infection	NA[2]	111	61	43
Slaughter Pig Testing				
Low Transmission	NA[2]	105	53	33
High Transmission	NA[2]	98	42	7

[1] Change Relative to Current Restrictive Policy of 33% Tariff Equivalent
[2] Not Applicable

Restrictive Policy. When the expected output loss due to PRRS is low, the welfare gain is $111 million. As the production losses increase, the welfare gains versus the Restrictive Policy are smaller. Mexico gains welfare if it is already infected, recognizes that fact, and eliminates all PRRS barriers rather than holding onto the Restrictive Policy. If the Restrictive Policy is retained after Mexico becomes infected, there is an unambiguous welfare decrease.

Of the situations where Mexico is treated as uninfected, the only policy option that allows trade is the Slaughter Pig Testing policy. When the probability of transmission and the expected loss are low, the premium is $1.32 per animal and imports to Mexico are 3.7 million head. Mexico gains welfare under this policy, $105 million, compared to the original 20-percent tariff plus Restrictive PRRS Policy. The medium-loss disease possibility has a premium of $1.40 and a welfare gain of $53 million. When the loss is expected to be high, the premium rises to $1.50 and Mexican imports rise to 4.7 million head as they experience a PRRS associated production loss of 1.6 million head. Of the Slaughter Pig Testing—Low Transmission scenarios, the High-Loss outcome exhibits the lowest social gain to Mexico because of the catastrophic PRRS loss and the higher trade barrier.

The commodity risk changes from 1 in one million to 1 in 100,000 in the next scenario, Slaughter Pig Testing—High Transmission. Altering the commodity risk raises the transmission probability; thus the premia are higher than under the Slaughter Pig Testing—Low Transmission case. The result is premia that range from $2.02 to $3.80. The level of Mexican imports range from 3.4 to 3.5 million head. There is a decreased level of trade in each of the Slaughter Pig Testing—High Transmission results versus Slaughter Pig Testing—Low Transmission, because the total barrier is higher. Accordingly, compared to the original restrictive policy, Mexican welfare gains are much lower in the Slaughter Pig Testing—High Transmission cases than in the Slaughter Pig Testing—Low Transmission situations. When the expected output loss is high and the transmission risk is high, there is little welfare gain over the existing policy.

Eliminating the one-time PRRS test considerably increases the transmission rate between the Slaughter Pig Testing policy and the Slaughter Pig No Testing policy. The probability of an outbreak increases from one in 36 million in Slaughter Pig Testing—High Transmission to one in 2 million in Slaughter Pig No Testing—Low Transmission. Increasing the likelihood of a PRRS outbreak by such a degree yields a jump in the premia. The premia that result in the Slaughter Pig No Testing policy are all trade prohibitive and lower welfare below that for the current policy. All of the other policies have even higher premia (Table 1). Therefore, neither Slaughter Pig No Testing, All Pigs Testing, nor All Pigs No Testing are feasible policy choices to replace the current import regulations, the Restrictive Policy.

The analysis suggests that of the policy options analyzed only the policy that separates swine into slaughter animals and which requires a PRRS test raises Mexican national welfare. Within the increased welfare, the change in policy alters the distribution of welfare. Compared to the current policy, consumers clearly benefit from the changed policy as the price in Mexico is reduced. The increase in consumer surplus ranges from $284 million in the low-transmission scenario to $214 million in the high-transmission scenario. Orden and Romano show that producers might gain from a disease outbreak as the price rise more than offsets the output quantity lost. The results in this analysis do not show such a pattern. Mexican swine producers lose welfare as the producer surplus loss ranges from $260 million in the low-transmission scenario to $301 million in the high-transmission scenario. A likely outcome is that the Mexican Government would compensate producers for their losses with Mexican taxpayers paying the cost.

Sensitivity Analysis

The premia are sensitive to the elasticities used in the model. The base elasticities used in the model give a very elastic excess demand since swine trade is small relative to the size of the herd. When the elasticities are lowered by 50 percent, the conclusions gained from the results change for the high-transmission-risk scenario. With the reduced elasticities only two of the three loss possibilities in the high-transmission scenario yield a welfare gain for Mexico. The high loss outcome gives a premium that results in reduced Mexican welfare and would not be a situation where the policy alternative is viable. More extreme results are obtained with a reduction in the assumed elasticities by 75 percent. All three possible losses under the high-transmission scenario yield welfare losses for Mexico. However, in the low-transmission case replacing the current policy with a liberalized policy using a premium yields a welfare gain, with the low loss possibility generating a \$4.3 million gain. These sensitivity results show that with extreme reductions in the elasticities, the policy change under conditions of a high-transmission-risk can provide Mexico with either welfare gains or losses depending on the loss level.

Policy Implications

The results of the model show several requirements are needed to create an import barrier based on risk. If the proper care is given in specifying this policy, it can link the PRRS risk to imports and provide welfare gains compared to the current Mexican policy, while still protecting the Mexican herd from PRRS. The analysis of the policies focuses on the ways that a policy must manage the PRRS risk associated with imports. The key features deal with "category discrimination" and the type of PRRS testing that is required.

Category discrimination describes the process of separating swine into two import categories and specifying regulations that deal with each group differently. Though each group has roughly the same infection rate, each group has very different transmission risks. The first group, breeding and feeder pigs, is assumed to have a transmission risk of 1.0. The second group, slaughter hogs, is assumed to have much lower risk, either one in 100,000 (0.00001) or one million (0.000001).

Carefully choosing the type of import requirement for each category of pig is very influential. Table 1 shows that no policy option that involves relaxing regulations for breeding or feeder pigs (All Pigs Testing or All Pigs No Testing) has a total barrier that allows trade. Category discrimination is used to develop tougher rules for breeding and feeder pigs in all of the feasible policy situations. Without a high protective barrier, breeder and feeder pig imports will cause production losses that are catastrophic. The opposite argument can be used for a slaughter hog category. Slaughter hogs represent a small risk to Mexico because once in the marketing chain there is a low level of contact between these animals and the domestic herd. Therefore, the reduced amount of risk that they pose should be reflected in import policy formulation.

The second crucial factor for diminishing the PRRS risk is the addition of mandatory testing within the category discrimination framework. Mandatory testing for feeder and breeder pigs is necessary before export because of the unacceptably high risk they pose to importers. As in the Slaughter Pig Testing policies, slaughter hogs need to test PRRS negative one time before being exported as the premia under the No Testing scenarios are prohibitive. Including the testing requirement allows Mexican officials to formulate a risk-based policy because it allows for a wider margin of safety.

In addition to difficulties in developing import regulations, the changing nature of the PRRS virus presents many problems. Therefore, it is crucial to know how PRRS disease characteristics affect the model. With this knowledge, policy makers can determine how precisely they need to predict the possible effects of the PRRS virus in Mexico. The two assumptions of key importance are the estimated loss associated with PRRS introduction and the commodity risk.

The PRRS loss variable is impossible to estimate precisely; thus its sensitivity is important to the value of the results. The three estimated impacts (Low, Medium, and High) determined the level of Mexican imports, but not whether a policy was prohibitive or not. The commodity risk was the variable which was most uncertain in the model and it heavily influences the probability of transmission, and thus the level of the premia. Though the commodity risk was crucial in creating the policies and linking them to a transmission risk, the commodity risk did not cause a prohibitive barrier but affected the level of trade. Implementing the single testing regimen for slaughter hogs creates a situation where assumptions about production loss and commodity risk affect the level of the trade but not whether a barrier is prohibitive. The main factor that eliminated trade was the jump in transmission risk with the omission of the one-time PRRS test.

Conclusion

This study examines the Mexican nontariff barrier created to mitigate the livestock health risk of the Porcine Reproductive and Respiratory Syndrome (PRRS) virus. The framework creates a barrier that adheres to international trading agreement rules on the elimination of disguised protection, while still protecting the health of the Mexican swine herd. Within a partial equilibrium framework, a premium compensates Mexico for the risk incurred by allowing imports of swine from PRRS-infected countries. Alternatives to the current Mexican import policy are analyzed. Additionally, three scenarios simulate the losses Mexico might incur if infected with PRRS. These various options allow for the determination of whether a risk-based barrier is less trade restrictive than the current regulations.

Two results of the model are crucial to formulating an import policy. The first concerns distinguishing between the slaughter hogs and feeder and breeding pigs. Feeder and breeder pigs transmit PRRS very easily and must be more strictly monitored before and during the import process. Slaughter hogs carry a much lower PRRS transmission risk and the results suggest a liberalization of current import rules. The second result supplements the first. Breeder and feeder pigs need to be strictly tested, but slaughter hogs need to be tested only one time to ensure both an acceptable level of risk for Mexico and a non-prohibitive, nontariff barrier.

The model results provide insights into the current Mexican import regulations which require strict testing and quarantine of pigs imported into Mexico. The model results confirm that regulations for the importation of breeding and feeder pigs do reflect their higher PRRS risk. However, current Mexican import rules do not capture the lower risk of slaughter hogs. The policy option that mitigates the PRRS risks while increasing the gains from trade is the Slaughter Pig Testing policy. The policy breaks the swine into categories and then deals with the risk associated with each category in the appropriate manner. Feeder and breeder hogs continue to be tightly tested and monitored, while slaughter hogs are tested only once.

References

Berentsen, P. and A. Dijkhuizen. "A Dynamic Model for Cost-Benefit Analysis of FMD Control Strategies." *Preventative Veterinary Medicine* 12(1992):229–243.

Dijkhuizen, A. and J. Renkema. "Modeling to Support Animal Health." *Agricultural Economics* 5(July 1991):263–277.

Economic Research Service. *Livestock, Dairy, and Poultry Outlook.* Washington, D.C.: ERS, USDA, various Issues (1993–1995).

Foreign Agricultural Service. *Import Health Requirements of Mexico for Slaughter Swine Exported from the United States.* United States Embassy, Mexico City, Mexico, November 1997.

Gardner, I. and T. Carpenter. "Financial Evaluation of Vaccination and Testing Alternatives for Control of Parnovirus-induced Reproductive Failure in Swine." *Journal of the American Veterinary Medical Association* 208(March 15, 1996):863–869.

Gardiner, W., V. Roningen, and K. Liu. *Elasticities in the Trade Liberalization Database.* Washington, D.C.: ERS, USDA, 1989.

Hillman, J. *Nontariff Agricultural Trade Barriers Revisited.* Lincoln, NE: University of Nebraska Press, 1978.

Hillman, J. *Technical Barriers to Agricultural Trade.* Boulder, CO: Westview Press, 1991.

Hurd, S. "The Acute PRRS Investigative Study: An Update," Animal and Plant Health Inspection Service, U.S. Department of Agriculture. Fort Collins, CO., 1997.

Josling, T. "An Analytical Framework for Assessing the Trade Impact of SPS and TBT Regulations." Contribution to the NRI Project on Classification and Analysis of SPS Regulations and TBT's in Agriculture, paper presented at the Technical Barriers to Trade Workshop, September 1997.

Krissoff, B., L. Calvin, and D. Gray. "Barriers to Trade in Global Apple Markets." *Fruit and Tree Nuts Situation Outlook.* Washington, D.C.: Economic Research Service, USDA, (August 1997):42–51.

National Animal Health Monitoring Service. *Swine '95.* Washington, D.C.: NAHMS, USDA, 1996.

Ndayisenga, F. and J. Kinsey. "The Structure of Nontariff Trade Measures on Agricultural Products in High-Income Countries." *Agribusiness* 10, 4(1994):275–292.

Orden, D. and D. Roberts. "Determinants of Technical Barriers to Trade: The Case of US Phytosanitary Restrictions on Mexican Avocados, 1972–1995." *Understanding Technical Barriers to Trade, Proceedings of a Conference of the International Agricultural Trade Research Consortium,* (January 1997):117–160.

Orden, D. and E. Romano. "The Avocado Dispute and Other Technical Barriers to Agricultural Trade Under NAFTA." Invited paper presented at the conference on NAFTA and Agriculture: Is the Experiment Working? San Antonio, TX. November 1996.

Paarlberg, P. and J. Lee. "Import Restrictions in the Presence of a Health Risk: An Illustration using FMD." *American Journal of Agricultural Economics* 80(February 1998):175–183.

Rendleman, M. and F. Spinelli. "An Economic Assessment of the Costs and Benefits of African Swine Fever Prevention." *Animal Health Insight.* Centers for Epidemiology and Animal Health, pp.18–17, Spring/Summer 1994.

Roberts, D. and K. DeRemer. "An Overview of Technical Barriers to U.S. Agricultural Exports." Staff Paper No. AGES-9705. Economic Research Service, U.S. Department of Agriculture. March 1997.

Rodriques, C. and I. Gardner. "Financial Analysis of Pseudorabies Control and Eradication in Swine." *Journal of the American Veterinary Medical Association* 197(November 15, 1990): 1316–1323.

Rothenberger, N. *Prevalence of PRRS in the United States.* Washington, D.C.: APHIS, USDA, 1997.

Sullivan, J., J. Wainio, and V. Roningen. *A Database for Trade Liberalization Studies. US Department of Agriculture.* ERS Staff Report, No. AGES89-12, March 1989.