Logistic Barriers to U.S.–Mexico Grain and Soybean Trade

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Fourteen years after the implementation of the North American Free Trade Agreement (NAFTA), border-crossing restrictions still remain with Mexico. Although studies have analyzed the impact of NAFTA trade liberalization, there has only been limited research on effects of informal trade barriers on U.S.–Mexico grain and soybean flows. This paper quantitatively measures the impact of logistic barriers impeding U.S.–Mexico grain and soybean trade. A conditional model testing for the presence of asymmetries in grain trade suggests that logistic barriers and transshipments are correlated. Econometric analysis rejects the null hypothesis of conditional independence, thereby implying the presence of asymmetries in grain transshipment markets.

Recent research pointed out the relevance of the impact of non-tariff trade barriers on international trade (De Groot et al. 2004). Among such barriers are sanitary restrictions, information costs related to physical (and cultural) distances, and institutional effects on trade flows (De Groot et al. 2004). According to De Groot et al. (2004) formal rules affect informal norms of behavior and inter-personal trust which influence the way of doing businesses, affecting risk perceptions and preferences in international trade. Some of these barriers are also defined as informal barriers. Informal barriers vary in form and have an indirect impact on trade (Menzie and Prentice 1987). These barriers include technical and health regulations, government procurement and distribution policies, various government subsidies and financial aids, transportation policies, and technical and administrative requirements. Although the North American Free Trade Agreement (NAFTA) has been in existence for 14 years, border-crossing restrictions still remain with Mexico, the second-largest U.S. agricultural-export destination. Bottlenecks include paperwork restrictions, customs clearance, health and sanitary restrictions, hours of services, second fumigations, road conditions, and port infrastructure issues that hamper U.S.–Mexico commodity flows. These land and ocean border-crossing restrictions can add significant costs to U.S. shipments to Mexico. Although several studies have analyzed the impact of trade liberalization by NAFTA, only a limited effort has been devoted to analyzing the impact of informal trade barriers on the U.S.–Mexico grain and soybean flow. This paper quantitatively measures the impact of logistic barriers that are more likely to hamper U.S.–Mexico grain and soybean trade.

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Overview of U.S.–Mexico Corn, Wheat, and Soybean Trade

Mexico is the second-largest destination, after Canada, of U.S. agricultural exports, estimated at $12.3 billion in 2007. U.S. agricultural exports to Mexico are forecast to increase to $13.7 billion in 2008 due to higher export unit values, stronger export demand for corn and cotton, and continued rapid growth of Mexico's middle class which is boosting import demand for a wide range of high-value products (ERS 2007b). Bulk commodities accounted for 63 percent of the total 28.9 million metric tons (mmt) of U.S. agricultural products exported to Mexico in 2006 (FAS 2007). Coarse grains represented 57 percent of total bulk agricultural shipments to Mexico. Soybeans and wheat accounted for 20 and 12 percent of the total 18.3 mmt of bulk exports, respectively.

Mexico processes much of its production of white corn into food products for human consumption. Approximately 30 percent of total Mexican corn consumption is imported. Almost the entirety of that 30 percent comes from the United States and consists of yellow corn for livestock feed to support increased meat production (FAS 2007; ERS 2007a).

During 2006, United States' corn exports to Mexico increased 34 percent from the previous year, to 7.83 mmt. More than half of the U.S. corn exported to Mexico was used as animal feed in 2004 (Adcock, Rosson, and Varela 2007). Thirty-seven percent was made into corn starch and 9.4 percent was used for flour, cereals, and snack foods.

Effective January 1, 2003, under NAFTA Mexico eliminated tariffs on almost all agri-food products with the exception of poultry, eggs, dairy, and sugar. However, corn and dry beans were subject to Tariff Rate Quotas (TRQs) until January 1, 2008 (Agriculture and Agri-food Canada 2006). When corn tariffs were eliminated in 2008, Mexico's imports of kibble or cracked corn, which were free of tariffs because they were processed, began to be replaced by imports of whole-grain corn (Hoffman et al. 2007). Over-quota U.S. white corn exports to Mexico were subject to import tariffs (72.6 percent in 2004, 54.5 percent in 2005, 36.3 percent in 2006, and 18.1 percent in 2007). The 2007 NAFTA corn TRQ was 3.672 mmt. Early in 2007, in accordance with the World Trade Organization (WTO), Mexico's Secretary of Economy announced two additional unilateral corn TRQs totaling 2.9 mmt of corn imported from Most Favored Nations (MFN). The TRQ was estimated at 86 percent for yellow corn and 14 percent for white corn (Juarez 2007a, 2007b).

Mexico is the third-largest world sorghum producer after Nigeria and the United States and the second-largest world consumer after Nigeria. In 2006, Mexico imported 28 percent of its sorghum, mostly from the United States (FAS 2007; SIAP/SAGARPA 2007). Sorghum is used exclusively for animal feed in Mexico (Adcock, Rosson, and Varela 2007). Mexican feeders are accustomed to feeding sorghum because corn imports have been limited by Mexican government policies (Hoffman et al. 2007).

The United States and Canada are the major suppliers of wheat to Mexico. The U.S. wheat market share in Mexico varies from year to year because of Canadian competition, which is based on quality and price (ERS 2007c, 2007d). U.S. wheat exports to Mexico consist mostly of Hard Red Winter (HRW) wheat due to the proximity of the large HRW wheat growing areas in the southern plains to the Mexican border. As a result of NAFTA, there are no tariffs on U.S. and Canadian wheat exports to Mexico.

Mexico is the world's fourth-largest world soybean importer, after China, the EU-25, and Japan. Mexican domestic production has virtually been displaced by U.S. imports due to Mexico's reform of its domestic-crop-support program, elimination of soybean tariffs as a result of NAFTA, and improvements in rail transportation links at the border (Ash, Livezey, and Dohlman 2006). In addition, strong income growth among Mexican consumers has boosted consumption of meat and vegetable oils and increased demand for soybeans. The following sections outline the various restrictions and requirements the United States and Mexican governments place upon grain shipments flowing across the border.

Regulatory Environment

Sanitary and phytosanitary (SPS) measures are nontariff trade barriers (NTBs) that impede trade, affecting its flow and magnitude. To assess the economic impact on trade flows of NTBs it is crucial to understand not only the grain and soybeans phytosanitary regulations but also their implementation at the U.S.–Mexico border. Regulation implementation varies by border-crossing points depending on the inspector's interpretation of the law and hours of service.

United States Grain Export and Import Requirements

The U.S. Department of Agriculture (USDA)[1] is responsible for providing the nation with safe and affordable food. Within this mission, the Agency's responsibilities have been divided between two agencies: the Grain Inspection, Packers and Stockyards Administration (GIPSA 2007) and the Animal and Plant Health Inspection Service (APHIS 2007). GIPSA's Federal Grain Inspection Service (FGIS 2007) is responsible for providing sampling, inspection, process verification, and weighing and stowage examination services that accurately and consistently describes the quality and quantity of the commodities being bought and sold in the nation, while APHIS is responsible for protecting

[1] The Food and Drug Administration protects public health and regulates food, medical devices, biologics, animal feed, drugs, cosmetics, and radiation-emitting products, but it is not covered in this study.

America's animal and plant resources. In addition, the United States Customs and Border Protection (USCBP 2007) agency of the Department of Homeland Security (DHS 2007) performs phytosanitary inspections for all imports to the United States. CBP is responsible for protecting the nation's borders in order to prevent terrorists and terrorist weapons from entering the United States, while facilitating the flow of legitimate trade and travel.

GIPSA Requirements

GIPSA requirements to export U.S. grain, oilseeds or related commodities from the United States vary based on whether the commodity (Table 1) is covered by the United States Grain Standards Act (USGSA) or the Agricultural Marketing Act of 1946 (AMA).

GIPSA is required to certify the quality and weight of all export shipments of grain covered by USGSA. GIPSA also is required to test all corn exports for aflatoxin, unless the contract stipulates testing is not required. Mandatory inspections and weighing are required for all U.S. ocean grain shipments to the rest of the world. However, these requirements do not apply to grain exported by rail or truck to Canada or Mexico.

APHIS Requirements

APHIS does not regulate grain and soybean exports to Mexico. Therefore APHIS cannot prohibit grain exports for lack of phytosanitary certificates. APHIS issues phytosanitary certificates in response to exporters' requests to meet Mexico's requirements. APHIS has a Memorandum of Understanding with the GIPSA/Federal Grain Inspection Service (FGIS) that allows it to sample and conduct phytosanitary inspections on behalf of APHIS. APHIS requires only an import permit for corn, wheat, sorghum, and soybeans imported from Mexico (Lamb 2007).

Mexican Phytosanitary Import Requirements

Mexico's phytosanitary requirements for the direct import of grains and seeds except for planting (SAGARPA 2006a), and not aimed at processing, transformation, and industrialization are:

Table 1. List of Export Commodities Required to Be Inspected under the U.S Grain Standards Act (USGSA) and the Agricultural Marketing Act (AMA).

U.S. Grain Standards Act		Agricultural Marketing Act	
Commodity	Registration required*	Commodity	Registration required*
Barley	Yes	Rice	No
Canola	Yes	Beans (dry edible)	No
Corn	Yes	Peas	No
Flaxseed	Yes	Lentils	No
Oats	Yes	Hops	No
Rye	Yes	Processed grain products(e.g., flour, cornmeal, soybean meal, vegetable oil)	No
Sorghum	Yes		
Soybeans	Yes		
Sunflower seed	Yes		
Triticale	Yes		
Wheat	Yes		
Mixed Grain	Yes		

*Anyone exporting 15,000 tons or more per year must register with GIPSA.
Source: GIPSA (2007).

a) International Phytosanitary Certificate (CFI) issued by the National Organization of Phytosanitary Protection of the country of origin, which indicates the place of origin of the product.
b) Phytosanitary inspection at the entry point into the country required for verifying the compliance of this Standard.
   i) If during the inspection live insects are not detected, the shipment will be released and it may enter the national territory.
   ii) If during the inspection the presence of living insects is detected, a quarantine treatment shall be applied and the shipment then will be released. The interested party will choose one of the authorized treatments.[2] The detected live insect will be sent for identification to a laboratory approved by the National Service for Animal and Plant Health, Food Safety and Quality (SENASICA) of the Ministry of Agriculture, Livestock, Rural Development, Fishing and Nutrition (SAGARPA).

[2] The exact method of treatment can be found in SAGARPA (2006).

c) Additional requirements by species and country of origin must be met as indicated in Table 2.

Treatment Certification at the Origin

When treatment is applied at country of origin, the dosage specifications, exposure time, and product must be indicated on the CFI issued by the National Organization of Phytosanitary Protection from the country of origin. In case the quarantine treatments are not specified or if they are different from those indicated in the standard, entry into Mexico will be conditional upon the application of the corresponding treatment at the entry point.

Railroad, Maritime, and Truck Transportation

Railroad, maritime, and truck transportation containers or packing used for the import of the products indicated in the present standard must be free of plant material debris. Where plant material and soil debris are detected, they must be cleaned and sprayed with a licensed chemical product having a current valid record with the Inter-ministerial Com-

Table 2. Mexico Additional Phytosanitary Import Requirements by Specie and Country of Origin.

Requirement #	Product	Origin	Phytosanitary treatment
G078	Corn and popcorn	U.S.A.	Aluminum phosphide TFA treatment applied at the country of origin is allowed. Otherwise, treatment T302 (d1), T302 (d2) or TFA will be applied at point of entry in Mexico.
G092	Soybeans	U.S.A.	Aluminum phosphide TFA treatment applied at the country of origin is allowed. Otherwise, treatment T302 (d1), T302 (d2) or TFA will be applied at point of entry in Mexico.
G095	Wheat*	U.S.A.	Aluminum phosphide TFA treatment applied at the country of origin is allowed. Otherwise, treatment T302 (d1), T302 (d2) or TFA will be applied at point of entry in Mexico.

*Additional requirements: the CFI must indicate that the shipment is free of *Tilletia controversa* and in the case of *Tilletia indica* must indicate that the shipment has not originated from Arizona, California, New Mexico, or the south of Texas (El Paso, Hudspeth, Culberson, Jeff Davis, and Presidio).
Source: SAGARPA (1998).

mission for the Control in the Process and Use of Pesticides, Fertilizers and Toxic Substances (CICOPLAFEST) and approved for authorized use for this purpose. If any plant material or soil debris is detected in or on the tops of the railcars or trucks, their entry into the country is not permitted. In this case, SAGARPA officials will notify other entry-inspection locations to alert them of the railcars or trucks that contain the debris. Cleaning of carriers must be done outside of the national territory. Railroad cars where plant material or soil waste is detected must not enter Mexico until they comply.

Phytosanitary Inspection

SENASICA official personnel inspect the grains and seeds (except those intended for planting), vehicle packing, and packing materials and review the shipment documentation before or at the entry point into Mexico. When a shipment is in compliance with the regulations of NOM-006-FITO-1995, SENASICA officials sign the Sanitary Import Permit (SIP). The SIP specifies the grain's intended use and destination in Mexico. Mexican Customs officials must also sign the SIP before the shipment is officially released.

When SAGARPA becomes aware of any potentially harmful phytosanitary conditions in an exporting country, they conduct a pest-risk assessment. Based on the result of the pest-risk assessment, SAGARPA will issue corresponding phytosanitary measures for minimizing risk of introducing these quarantine pests into Mexico. When it is verified that the stated products regulated in the standard do not comply with the respective phytosanitary provisions, SAGARPA will refuse entry and order their return, destruction, or reconditioning, with the cost being borne by the importer or by an interested party.

Based on the Federal Act of Vegetable Sanitation, SAGARPA randomly monitors the grain and seeds, except those intended for planting, imported for processing, transformation, and industrialization; their transport and management under conditions that prevent product leakage, to assure that the product arrived at the declared final destination; and that there is compliance with the processing, transformation and industrialization systems approved by SAGARPA (2006).

U.S.–Mexico Border-Crossing Restrictions for Corn, Wheat, and Soybean Trade

The implementation of Mexican phytosanitary regulations at the U.S.–Mexico border is the main source of delays in U.S. grain and soybeans entering Mexico. Inspection processes vary by point of entry. During the process, five major sources of train delays have been identified (Table 3).

Hours of Operation

National Service for Animal and Plant Health, Food Safety and Quality (SENASICA) hours of service: The hours of operation are limited by the Mexican Law of Administrative Procedures which prohibits federal inspectors from working overtime. SENASICA sampling usually occurs in the cooler morning hours. Hours of operations vary by point of entry.

The Nuevo Laredo office is open Monday through Friday, 8:00 a.m.–4:00 p.m. The office is closed on weekends and holidays but they do inspect the tops of railcars for plant material and soil debris 24 hours per day, seven days a week during the year. Sampling is performed Monday through Friday by private contractors. With advance notice, sampling may be done on weekends.

The Matamoros office is open Monday through Friday, 9:00 a.m.–5:00 p.m. and until 4:00 p.m. on Saturday. Inspections may continue until 5:00 p.m. on Saturday. If SENASICA does not complete their sampling by 5:00 p.m., they will continue the next morning or next business day. Sampling is done by private contractors.

The Ciudad Juarez office is open Monday through Friday, 8:00 a.m.–5:00 p.m., and from 9:00 a.m. until noon on Saturday. Sampling is done by SENASICA inspectors.

Number of Inspectors

There are a limited number of SENASICA inspectors due to Mexico budget constraints. For example, in Nuevo Laredo, the busiest border crossing, there are only 13 inspectors for all agricultural products.

Documentation Requirements

Determination of what is considered an original export document: there is no consistency for sig-

Table 3. U.S.–Mexico Border Crossing Average Delays by Selected Point of Entry*.

Description	Delays
Collection of original export documents, Fig. 1	48–72 hrs.
Export documents clearance:	1–3 days
Identification of dirty cars:	< 1 hr.
a) by circuit cameras	Nuevo Laredo
b) Cross net[1]	Matamoros and Ciudad Juarez
Clean top railcars[2] by private contractors	1–2 days
10 percent random sample[3] of railcar inspected by private contractor	1–2 hrs.
Second grain fumigation, paid by the importer[4]	48 hrs.
SENASICA issue sanitary import permit ($1,300)	2–3 hrs.
Mexican custom	2–24 hrs.
Sample cars reassemble to final destination	2 days–2 weeks

*Points of entry: Ciudad Juarez, Matamoros, and Nuevo Laredo.
[1]Cross net: a person is seated on a 50–60 ft. stand with huge stadium lights looking at the top of the rail car under all weather conditions, 24 hrs/7days per week. The train moves continuously at about 1 mph.
[2]Dirty cars have a weight tolerance of 50 pounds of grain debris on top of a single railcar. If debris weight exceeds this limit, the car is rejected and returned to the United States for cleaning. All debris cleaned off cars is bagged and returned to the United States in a single box car designated for that purpose. Expenses are paid by U.S. railroads.
[3]Railcar sampling varies according to the commodity: 100 percent for soybeans, 40 percent–60 percent for wheat, ten percent for other grains.
[4] Can be performed in the United States.

natures or color of ink; some inspectors require documents to be signed in blue ink as opposed to black ink in order to distinguish an original document from one which is a photocopy.

Second Fumigation

A second fumigation at the border is not required unless live insects are detected during the inspection process.

Cleaning the Tops of Railcars

The tops of all railcars must be clean. It is the responsibility of the U.S. railroads to clean the top of the car. However, rail cars are allowed to be cleaned in Mexico. The collected debris is returned to the U.S. in a designated boxcar. Likewise, debris collected from the empty railcars returning to the U.S. is sent back to Mexico in the same designated boxcar.

To understand the delays at the U.S.–Mexico border, it is critical to comprehend the border-crossing clearance process. This process involves:

1. Export document handling
2. National Service for Animal and Plant Health, Food Safety and Quality (SENASICA) inspection processes
3. Custom agency release
4. Sanitary import permit

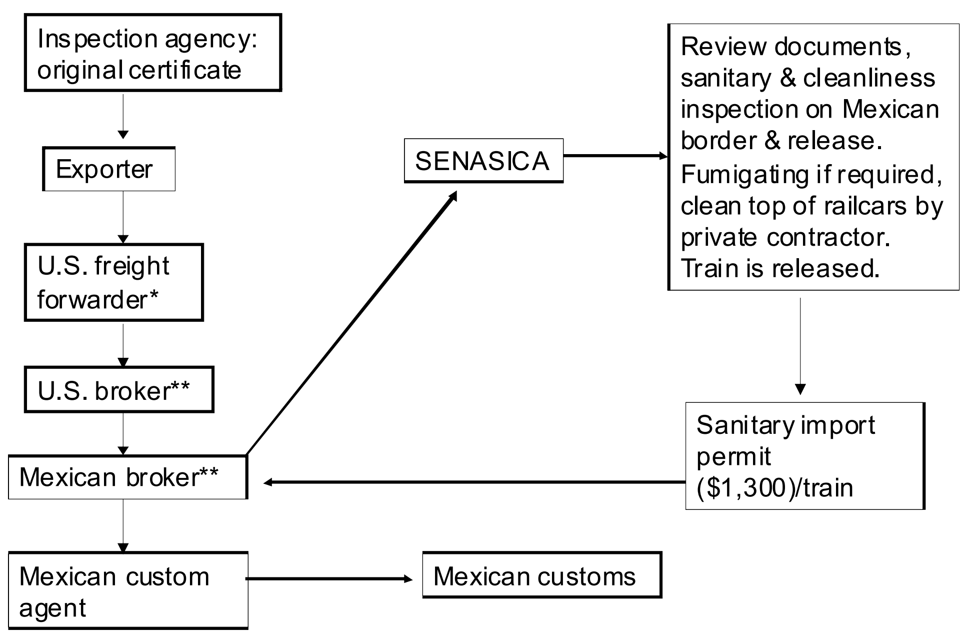
Export Document Handling

The sequence of events is as follows: original export documents are handled from the inspection agency to the exporter to the U.S. freight forwarder to the U.S. broker to the Mexican broker to the Mexican customs agent and finally to the SENASICA and Mexican Customs (Figure 1). The Mexican government requires original copies of certificates. GIPSA issues official grain inspection and weight certificates, while APHIS issues official phytosanitary certificates. Certificates with typos are not accepted because of the concern about fraudulent documents. There is no consistency for the signatures' color of ink; some inspectors require documents to be signed in blue ink while others in black ink. Shipping of original documents by overnight mail might take 48–72 hrs. It should be noted that SENASICA's inspectors do not get paid overtime for after-hours, holidays, and weekend inspections. In addition, some inspection offices require the export documents to be delivered no later than by 2:30 p.m. Monday through Friday, while others may require the documents no later than by noon on Friday. No SENASICA offices process the export documents on weekends or holidays. Currently, SENASICA is working to change the interpretation of the Mexican Law of Administrative Process to redefine "original document" in order to expedite the clearance process. In this way, electronic certificates available over the internet will be accepted as originals. As of June, 2007, GIPSA began issuing inspection certificates online and APHIS is in the process of implementing this procedure as well.

SENASICA Inspection Processes

After SENASICA reviews and clears all export documents, trains are allowed to enter Mexico and to proceed to the SENASICA inspection station close to the border. Railcar sampling is usually performed by private contractors. FGIS does not consider Mexican samples representative because their sampling procedures are not consistent at all entry gateways and when sampling they use a four-foot-long open-throat probe, which does not obtain a representative sample. FGIS uses a 12-foot-long compartmented probe for sampling to reach the bottom of the railcar.

SENASICA requires that ten percent of all grain railcars be inspected except for soybeans and wheat. In the latter case, 100 percent of soybean railcars are sampled due to concerns about Asian soybean rust (*Phakopsora pachyrhizi*). Samples are sent to a local private laboratory for analysis. The laboratories are usually chosen by the buyer. Furthermore, an official FGIS inspection certificate is required



*The same person can be the U.S. freight forwarder, U.S. broker, and the Mexican broker.
**Usually, the same person. The Mexican broker hand deliver documents to SENASICA.

Figure 1. Export Document Handling Procedures.

certifying that soybeans contain less than 2.0 percent of foreign material. If there is a quarantine concern, such as *Tilletia controversa J.G. Kühn* (TCK) smut in wheat shipments, SENASICA will send the samples to a Mexican-government-accredited laboratory for further analysis. Sampling for wheat shipments varies between 40–60 percent of the shipments. Wheat originating from areas that had Karnal bunt (*Tilletia indica*) outbreaks requires a 60-percent sampling. All wheat shipments must be certified as free of TCK smut.

SENASICA inspects all railcar exteriors for cleanliness. Railcars arriving with plant and soil debris on top must be cleaned by a private contractor paid by the U.S. railroads. A private fumigation company, paid by the importer, fumigates railcars because all grain entering Mexico must be fumigated with aluminum phosphide[3] or methyl bromide at origin or upon entering Mexico, in accordance with NOM-006-FITO-1995. Fumigation can take place in the United States, but it must be officially witnessed and documented by FGIS, State, or official inspection personnel. If there is no documentation of observed fumigation, Mexico will require all cars to be re-fumigated in Mexico. Trains that are fumigated with aluminum phosphide at origin typically are allowed to enter Mexico once SENASICA clears all documents.

Customs Agency Release

Mexican Customs are open from 9:00 a.m. to 5:00 p.m. Monday through Friday and from 10:00 a.m. to 2:00 p.m. on Saturday. After SENASICA clears the documents and takes their samples, Mexican Customs will then inspect five to seven percent of the railcars to ensure proper tariffs were assessed. The railroad pulls the selected railcars from the train onto another track for Customs inspection. Once their inspection is done, they will sign the Sanitary Import Permit (SIP) and contact the railroad to switch those railcars back into the waiting train.

The train is then released and allowed to proceed to the receiver once fumigation has finished. Although the train is officially released by SENASICA and Customs authorities, the railcars may stay in the rail yards for two or more additional days before the train continues on its route.

[3] Aluminum phosphide is the only fumigate approved to be used on grain in the United States.

Data and Variables

Total U.S. corn, sorghum, wheat, and soybean export data to Mexico were obtained from the Department of Commerce, U.S. Census Bureau, Foreign Trade Statistics, in the USDA/Foreign Agricultural Service (FAS), U.S. Trade Exports, FATUS Commodity Aggregations website (FAS 2007). Modal-share transportation data were obtained from several sources: data for grain shipped by rail was obtained from the Surface Transportation Board's (STB) Carload Waybill Sample (STB 2001-2005); data for grain shipped by ocean were obtained from the USDA/Grain Inspection, Packers and Stockyards Administration (GIPSA 2007); and data for grain shipments by truck is the residual of total exports minus rail and ocean shipments. This study focuses on shipments by rail only.

There are no published data on the final destination of U.S. grain and soybean exports to Mexico. Major rail destinations in Mexico were estimated based on information from Adcock, Rosson, and Varela (2007) as well as from personal conversations and observations made on site. Sanitary requirements were obtained from the Ministry of Agriculture, Livestock, Rural Development, Fishing and Nutrition (SAGARPA). U.S.–Mexico border-crossing restrictions were based on personal observations made on site. The logistic barriers variable represents delays generated by sanitary requirements and border-crossing restrictions based on personal observations on site. This is a discrete variable, capturing a bundle of border-crossing restrictions. A significant coefficient for transshipments embodies asymmetric information between transshipments and logistic barriers. Also, the expected value of transshipments in the model specification accounts for the nonlinear effects of all variables on logistic barriers given that the goal is to test for correlation between logistic barriers and transshipments.

Cost includes fumigation and rail-car cleaning charges/expenses at the Mexico border. The data were obtained from personal communications and observations on site. Grain transshipments capture the shipments of grain in million metric tons obtained from the Department of Commerce, U.S. Census Bureau, Foreign Trade Statistics (FAS 2007). If the transshipments variable is not significant, then the cross-border transshipment market lacks the presence of asymmetries due to regulations and other impediments or transshipments do not provide useful information in predicting conditionally informal policies that inhibit shipments of grains and soybeans between the U.S. and Mexico.

The trains (number) variable represents the frequency, number, and size of trains crossing the border. Data were obtained from the Surface Transportation Board's Carload Waybill Sample (STB 2007). Tonnage represents the shipments per average train size to account for dispersion and variability of train shipments. Cost refers to fumigation of soybean and wheat railcars with methyl bromide. Total cost was calculated to reflect the number of trains and cars by train. Dummy variables were used to capture possible differences in grain category transshipments assuming fixed effects specification. We specified two dummy variables, one for grains (corn and wheat) and the other for soybeans transshipments. The Univariate method (Chan 1993) was used to develop quarterly data series from the annual data available in the Statistical Analysis System (SAS) 2003.

Estimated Border-Crossing Restrictions Economic Impact: Model and Results

Theoretical Specification

The determinants of transshipments are usually examined within the framework of a standard gravity model with the usual explanatory variables of distance and country size to infer the impacts of institutions on trade flows (McCallum 1995; Obstfeld and Rogoff 2000; Grossman 1998; Trefler 1995). Because of the importance of transportation and trading costs, a rapidly growing literature is aimed at measuring and understanding trade border effects and barriers (Anderson and Smith 1999; Head and Ries 1999; Wolf 2000; Fink, Mattoo, and Neagu 2002; Clark, Dollar, and Micco 2004).

Unlike previous work, this paper attempts to analyze the impact (if any) of informal trade barriers on the U.S.–Mexico grain and soybeans transshipments. The dominant view today is that the regulatory process, formal or informal, is used by industry to erect entry restrictions for its own benefit (Stigler 1971). Economic theory demonstrates that regulatory processes are associated with asymmetries of information that can hinder the efficient operation of markets. For this reason, advances in the literature of contracting and asymmetric information are employed to quantitatively evaluate the impact (if any) of informal trade barriers on the U.S.–Mexico grain and soybeans trade flows.

Rothschild and Stiglitz's (1976) theoretical model derives market-equilibrium conditions under asymmetries of information. Puelz and Snow's (1994) theoretical work developed measures of informational asymmetries in the insurance and automobile markets. Dionne, Gourieroux, and Vanasse (1998) model introduced the notion of conditional dependence in their effort to measure asymmetries of information. Chiappori and Heckman (2000), based on the notion of conditional dependence, developed the so-called "positive correlation" test to measure the presence of informational asymmetries. This paper specifies a conditional model to analyze the factors that influence U.S.–Mexico grain and soybean transshipments and assert the economic impact of informal logistic barriers using the concept of conditional independence. Rejection of independence means that there is evidence of informational asymmetries in the U.S.–Mexico transshipment market (Chiappori and Salanie 2000; Dionne, Gourieroux, and Vanasse 1998). In other words, if logistic barriers are correlated with grain and soybean transshipments, then there are asymmetries of information on the U.S.–Mexico grain and soybean trade.

Conditional Independence

Let Y be the endogenous variable under study or U.S. transshipments to Mexico, θ be the decision variable (in this case, logistic barriers), and X a matrix of exogenous variables. The decision variable provides no additional information if and only if the prediction of $f(Y)$ based on X and θ jointly coincides with its prediction based on X alone. This conclusion can be written in terms of conditional probabilities as

(1) $f(Y/\mathrm{X},\theta) = f(Y/\mathrm{X})$,

where $f(./.,.)$ denotes a conditional probability-density function (Gourieroux and Monfort 1995). In this application, Y is transshipments, θ is logistic barriers, and X includes the exogenous variables.

The non-linear specification of Equation 1 means that the presence of logistic barriers, θ, provides no useful information in predicting transshipment, Y. In other words, if the equation above holds, then we can conclude that θ and Y are independent, conditionally on X. Equation 1 can be written in equivalent form as

(2) $f(\theta / X, Y) = f(\theta / X)$,

where transshipments do not provide useful information in predicting conditionally logistic barriers. This characterization may also be interpreted as the description of what the traders or transshipping companies would decide if there is no additional knowledge of logistic barriers (Dionne, Gourieroux, and Vanasse 2001). If traders have more information than do the agencies that impose the barriers, then the equality will not hold in Equation 2. In this application, such a characterization was used.

"Conditional dependence" means conditional on all variables observed by the traders. That is, several other factors—including the number of trains, the fumigation cost, and the type of grain—also influence the logistic barriers. The model that tests for independence of logistic barriers and transshipments should account for those factors. The econometric model can also be used to control for factors that might affect logistic barriers. In this paper, the econometric model is specified in general form as

(3) $f(\theta, Y/X) = f(\theta, Y, \hat{E}(Y/X), X)$,

where $\hat{E}(Y/X)$ is the expected value of Y computed from initial information. By introducing the estimated expectation of logistic barriers ($\hat{E}(Y/X)$) in Equation 3, any omitted non-linear effects are accounted for. That is, Equation 3 avoids the difficulty of distinguishing the informational content of a decision variable and any omitted non-linear effect of the initial exogenous variables (Dionne, Gourieroux, and Vanasse 2001). If the estimated coefficient of Y is no longer significant when $\hat{E}(Y/X)$ is introduced into the model, this means that there are no informational asymmetries in the transshipment U.S.–Mexico market and logistic barriers have no impact on the grain and soybean trade flows.

The relationship in Equation 3 was used to specify a two-limit Tobit model to analyze the impact of regulatory policies as

$$(4)\quad \theta = \begin{cases} \theta_L & \text{if } \theta^* \le \theta_L \\ \theta^* = \alpha y + \lambda E(y/x) + x\beta + \varepsilon_i & \text{if } \theta_L < \theta^* < \theta_U \\ \theta_U & \text{if } \theta^* \ge \theta_U \end{cases},$$

where θ is logistic barriers, which ranges from a minimum of ten percent (θ_L) to a maximum of 95 percent (θ_U); α, λ, and β are regression coefficients; and ε_i is the residual that is independently and normally distributed. The two-limit Tobit model is appropriate when the dependent variable is truncated at both high and low values (Long 1997; Maddala 1987).[4] In the case of logistic barriers measured as delays, there is a minimum of ten percent and a maximum coverage of 95 percent. The set of relevant explanatory variables in Equation 4 includes the number of trains, the tonnage, the fumigation cost, and the type of grain (as described above).

Econometric Results

U.S.–Mexico grain and soybean transshipments were analyzed using a two-limit Tobit model described in Equation 4 using the EViews (2007) statistical package. Variables closely related to the transshipping market's characteristics were focus upon. Two non-linear models were estimated: Model 1 excludes the expected value of transshipments, while Model 2 includes the expected value of transshipments and it is used to test the correlation between logistic barriers and transshipments.

In Model 1, logistic barriers are specified as a function of all available variables except the expected value of transshipments. The expected values of transshipments, $\hat{E}(Y/X)$, are computed from an estimated negative binomial model of transshipments. Transshipments are estimated as a function of all the available information, X, using the negative binomial regression model $Y = f(X)$ and then the expected value of Y or $\hat{E}(Y/X)$ is computed. The expected value of transshipments is incorporated only into Model 2 to account for the nonlinear effects of explanatory variables. In Model 2, logistic barriers are specified as a function of all available variables including the expected value of transshipments. The main goal is to test for correlation between the logistic barriers and transshipments.

The econometric results suggest that logistic barriers and transshipments are correlated or that

[4] See Long (1997, pp. 212) or Maddala (1987, pp. 160) for more on the two-limit Tobit models.

the null hypothesis of conditional independence is rejected, implying the presence of information asymmetries in grain transshipment markets. In Model 1, the transshipment coefficient is positive (0.09), implying that larger transshipments are more likely to face higher logistic barriers and vice versa. The z score (8.93) indicates that the transshipments coefficient is statistically significant at one-percent level of significance (Table 4). In Model 2, transshipments and the expected value of transshipments have a strong positive relationship. In particular, the coefficients of transshipments and the expected value of transshipments are 0.11 and 12.12, respectively, and they are statistically significant at the one-percent level of significance with z scores 18.38 and 12.02, respectively (Table 4). These strong positive values indicate positive correlation between the logistic barriers and transshipment and imply the presence of asymmetries in the U.S.–Mexico grain and soybean trade flow markets.

The results also indicate that logistic barriers depend on cost, tonnage, number of trains, and types of commodity. Specifically, the results reveal a strong positive relationship between tonnage and logistic barriers in both models (Table 4). The estimated coefficients for Model 1 and Model 2 are 1.24 and 1.33, respectively. The positive and statistically significant coefficients (with z values 12.13 for Model 1 and 21.57 for Model 2) indicate that traders with larger tonnage have a higher probability of facing increased logistic barriers.

The estimated relationship between number of logistic barriers and trains is positive and significant (Table 4), as trains with larger numbers of cars are more likely to face higher logistic barriers and vice versa. This reinforces the rejection of the null hypothesis and supports the notion of asymmetrical information in the U.S.–Mexico grain and soybean transshipping markets. Specifically, the estimated coefficients are 0.18 and 0.10 for Model 1 and Model 2, respectively, and they are statistically significant at the one-percent level of significance, with z scores 11.55 for Model 1 and 20.60 for Model 2.

As expected, the coefficient of inspection cost is positive, indicating that sanitary and phytosanitary measures impede trade and affect its flow and magnitude (Table 4) in the case of rail transship-

Table 4. Two-limit Tobit on Logistic Barriers as a Function of Transshipments and other Variables.

Variable	Model 1: Conditional on transshipments		Model 2: Conditional on transshipments and expected transshipments	
	Coefficient	Z-ratio	Coefficient	Z-ratio
Intercept	−2.19	−8.82*	−3.53	−19.04*
Transshipments (Y)[1]	0.09	8.93*	0.11	18.38*
$\hat{E}(Y/X)$[2]			12.12	12.02*
Tonnage	1.24	12.13*	1.33	21.57*
Cost (average)	0.07	5.46*	0.11	13.22*
Trains (number)	0.18	11.55*	0.19	20.69*
Grain type1 (dummy)	0.29	3.23**	0.09	1.56
Grain type2 (dummy)	0.08	0.92	0.07	1.32
Adjusted R^2		0.74		0.91

[1] Y is the transshipments.
[2] $\hat{E}(Y/X)$ is the estimated expected transshipments.
* Statistically significant at one-percent level of significance.
**Statistically significant at five-percent level of significance.

ments. Although the estimated coefficients are positive (0.07 for Model 1 and 0.11 for Model 2) and significant, their magnitude indicates a rather weak relationship with logistic barriers compared to the other explanatory variables in the models. Dummy variables were used to capture possible effects of logistic barriers and category of commodity (Dummy 1 for corn and wheat and Dummy 2 for soybeans). The estimated coefficients are positive but they are not statistically significant (Table 4), indicating that the differentiation of the type of commodity is not important.

Conclusions and Further Research

This study specifies and tests for the presence of asymmetries in the U.S.–Mexico grain trade. The data pertain to U.S. corn, sorghum, soybean, and wheat quarterly transshipments for the crop year 2002–2006. This study focuses on shipments by rail only.

The data gathered for the study provide an opportunity to test for asymmetries in U.S.–Mexico grain commodity flows. A conditional model is specified to estimate the economic impact of logistic barriers to U.S. corn, wheat, and soybean shipments to Mexico. In other words, the conditional independence of logistic barriers and grain transshipments after accounting for transportation differences is tested. The model specification allows testing for asymmetries in the U.S.–Mexico transshipping grain and soybean market using a parametric approach. The procedure rejects conditional independence between the logistic barriers and the transshipments, implying the presence of asymmetries between traders at border crossings. Findings provide insights into border-crossing grain shipments and the methodology allows for an assessment of logistic barriers in U.S.–Mexico trade practices.

Whether the problem of asymmetries is intrinsic to U.S.–Mexico grain transshipment or whether it is a consequence of policies applied is beyond the scope of this paper. However, government regulations might contribute to the presence of asymmetries as regulations and are a potential source of asymmetrically used information. For example, when policies or procedures are in place which allow traders to condition the shipments on well-established guidelines, then trade flows should greatly improve. Also, incentives to monitor problems generated by logistic barriers would reduce or eliminate asymmetries in the grain transshipments between the U.S. and Mexico.

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