PRIVATIZATION OF MEXICO'S RAILROAD SYSTEM AND IMPLICATIONS FOR U.S./MEXICO GRAIN/OILSEED TRADE

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PRIVATIZATION OF MEXICO’S RAILROAD SYSTEM AND IMPLICATIONS FOR U.S./MEXICO GRAIN/OILSEED TRADE

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ABSTRACT: This study examines whether privatization of Mexico’s state-owned railroad would have unfavorable implications for U.S. overland grain/soybean exports to Mexico. Ex post privatization, railroad costs and demands in combination with intramodal/intermodal competition will determine rail carrier rates. Rates are likely to change with privatization and because grain is a low-valued bulky commodity whose geographic flow pattern is sensitive to transportation rates, privatization may be disruptive to overland grain/soybean exports. Analysis is accomplished with international spatial models of the corn, soybean and grain sorghum sectors. Results show U.S. overland exports of these commodities to increase from 3.50 million metric tons (mmt) to 6.433 mmt as a result of privatization. This is a result of lower costs/rates projected for a privatized system and competitive transportation markets. Thus, concern that privatization will hinder the U.S.’s ability to compete in Mexican grain/soybean markets is unwarranted.
EXECUTIVE SUMMARY:

The objective of this study was to determine whether privatization of Mexico’s state-owned railroad would have unfavorable implications for U.S. overland grain/soybean exports to Mexico. Ex post privatization, railroad costs and demands and intramodal and intermodal competition will become important determinants of transportation rates. Thus, rates are likely to change and because grain is a low-valued, bulky commodity whose geographic flow pattern is sensitive to transportation costs, privatization may be disruptive to U.S. overland grain exports to Mexico.

The study focuses on U.S. sorghum, soybean, and corn exports; analysis is accomplished with spatial models of these sectors. A heuristic procedure is followed with the spatial models for purposes of determining the profit-maximizing rates likely to be charged by a privatized railroad in the various Mexican transportation markets. The analysis assumes that costs of the privatized Mexican railroads will come to approximate that of the average U.S. carrier.

Results suggest privatization of the Mexican railroad system has the potential to dramatically increase U.S. grain/soybean exports to Mexico via overland routes. Pre-privatization analysis show U.S. overland exports to Mexico of 3.50 mmt; U.S. rail carriers are projected to carry 3.144 mmt to border locations with the FNM and Mexican truckers transporting 2.540 and 0.96 mmt, respectively, to Mexican demand centers. The post-privatization analysis shows U.S. grain/soybean overland exports to Mexico increase to 6.433 mmt, an increase of 2.933 mmt over the pre-privatization scenario. Railroads in the U.S. transport an estimated 6.201 mmt to border locations where all is transferred to the privatized Mexican railroads for delivery into Mexico. The Northeast system is projected to transport over three-fourths of the overland exports to Mexican destinations.

The projected increase in U.S. overland grain/soybean exports to Mexico result from significant reductions in the railroad costs of privatized carriers and the competitive transportation environment that allow rail carriers to only modestly increase rates above variable costs. For example, under the FNM rate structure, rates for feedgrain movements from U.S. border crossing sites to Central Mexico ranged from $24 to $27/ton, whereas under privatization the rate is projected to decline to about $19 per ton and carriers are expected to generate a revenue-to-variable cost ratio on this haulage of about 1.2. Railroad rates are constrained by intramodal competition on many important routes because of trackage rights specified by the government of Mexico in the privatization process. In addition, intermodal competition, as offered by ship/truck and ship/rail combinations provide important competition to rail carriers in selected Mexican grain/soybean markets.

In summary, privatization of Mexico’s railroad system has the potential to dramatically increase U.S. overland exports of grain/soybeans to Mexico. Thus, concern that privatization of Mexican railroads will hinder U.S. agriculture’s ability to compete in the Mexican grain/soybean markets is unwarranted; in fact, the analysis shows U.S. producers annual grain/soybean revenues may increase $42 million per year as a result of privatization.
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PRIVATIZATION OF MEXICO'S RAILROAD SYSTEM AND IMPLICATIONS FOR U.S./MEXICO GRAIN/OILSEED TRADE

Mexico has become an important importer of United States grain/oilseed during the 1990's. Nearly half of the U.S.'s grain/oilseed exports to Mexico enter that country via overland crossings on the U.S./Mexico border. Railroads in the United States transport grain/oilseed from U.S. origins to U.S./Mexico border crossing locations where the railcars are transferred to a Mexican railroad for transport to demand centers in Mexico. Historically, the Ferrocarriles Nacionales de Mexico (FN M), the state-owned railroad of Mexico, transported railcars with FN M power and under a rate structure determined by Mexico's Secretaría de Comunicaciones y Transportes. In 1995, the Mexican government announced that the Ferrocarriles Nacionales de Mexico would be privatized. Privatization of the Mexican railroad would seem to have important implications for U.S. overland exports since railroads will become profit-maximizers thus altering the overland rate structure which historically included cross-product subsidies and other non-economic characteristics (Estrada). In a market environment, railroad costs and demands, and intramodal and intermodal competition will become important determiners of transportation rates. Since grain is a low-valued, bulky commodity whose geographic flow pattern is sensitive to transportation/logistics costs, privatization may be disruptive to U.S. overland grain exports to Mexico. The objective of this study is to determine how privatization of the FN M will likely affect the United States overland grain/oilseed exports to Mexico and the welfare of U.S./Mexican producers.

BACKGROUND

Although the FN M has become a relatively effective partner in the transportation of U.S. railcar shipments of grain to Mexico it has been unable to overcome inefficient utilization of labor and capital and an inefficient pricing scheme (Estrada). These inefficiencies lead to financial difficulties and in 1989, 1990 and 1991, operating deficits of $449, $549 and $552 million were experienced (Klindworth and Martinsen). At the same time, increased competition from motor carriers and shipping companies (cabootage) decreased FN M's share of the freight market to about 9 percent and, in late 1994, the Mexican Congress elected to privatize the state railroad through a series of 50-year concessions.

Privatization plans call for dividing the FN M into three mainline operations, a terminal railroad and several shortlines; these will include the Northeast, Pacific-North and Southeast mainlines and a terminal railroad which is to serve the Valley of Mexico (Bech). In December 1996, a consortium, the Transportacion Ferroviaria Mexicana (TF M), which includes the Mexican ship company, Transportacion Martima Mexicana (TMM) and Kansas City Southern Industries (KCSI), were the announced buyers of the Northeast with a bid of$1.4 billion (Millman, January 31, 1997). The Northeast is a 2600 mile network that connects Laredo and Brownville, Texas to
Monterrey, Mexico, an industrial hub in north Mexico, and to Mexico City. In addition, this mainline (1) connects Mexico City to the Mexican Gulf port at Veracruz and to the Pacific port at Lazaro Cardenas, (2) connects the port at Tampico to Aguascalientes via San Luis Potosi and (3) receives trackage rights on the Pacific-North system into Guadalajara, the country's second largest city. The Northeast railroad interlines with the Union Pacific Southern Pacific system at Brownsville and Laredo as well as the Texas-Mexican Railroad, a short-line operating between Corpus Christi and Laredo, Texas. The Texas-Mexican Railroad is owned by the TFM consortium. As part of the merger between Union Pacific and Southern Pacific, the Texas-Mexican Railroad was granted trackage rights between Houston and Corpus Christi. In addition, the Burlington Northern Santa Fe (BNSF) was granted trackage rights between Houston and Brownsville, thus providing the TFM access to the grain-gathering capability of the BNSF and UPSP systems as well as KCSI's north-south trackage that links Omaha, Nebraska with Houston/Beaumont.

In June, 1997 the Mexican government awarded the Pacific-North concession to Grupo Ferroviero Mexicana (GFM), a consortium that includes the Union Pacific Corporation, and two Mexican companies (Millman, June 27, 1997). The winning bid of $396.3 million purchased 80 percent ownership in the 3900 mile system; the government of Mexico retains ownership of the remaining portion. The Pacific-North system connects Guadalajara and Mexico City in Central Mexico to border crossings at Eagle Pass and El Paso, Texas; Nogales, Arizona; and Calexico, California. In addition, this system connects to the Gulf port at Tampico and Pacific ports at Guaymas, Mazatlan, and Manzanillo. The Pacific-North has been granted trackage rights on that portion of the Northeast system that extends from near Saltillo to the Mexico City area. The Pacific-North system has relatively low traffic density and in the past has generated about 60 percent of the per mile revenues of the Northeast system (Burke, March 17, 1997). The Pacific-North system will interline with the UPSP at its four US/Mexico border crossing locations and with BNSF at El Paso and Eagle Pass, Texas through trackage rights agreements. The third mainline system (Southeast) is to operate between the Mexico City area, the port at Veracruz and the Yucatan peninsula. The terminal railroad, Valley of Mexico, is to operate in the Mexico City area and will be owned jointly by the Northeast, Pacific-North and Southeast railroads as well as an urban passenger line (Beachy).

Corn, sorghum, wheat and soybeans are the principal U.S. grain/oilseed exports to Mexico. Historically, the United States supplied virtually all of Mexico's imports of these commodities; the recent exception is wheat, which has been imported from Canada. During the 1990-95 period, the U.S. annually exported an average of 8.4 million metric tons (mmt) of corn (2.2 mm), sorghum (3.4 mm), wheat (1.0 mm), and soybeans (1.8 mm) to Mexico (Klingworth and Martinsen). The routing of U.S. grain/soybean exports to Mexico tends to vary by commodity. On average, about 45 percent of these exports moved via overland routes during the 1990-1994 period while the remainder (55 percent) moved by ocean transport to Mexico's Gulf and Pacific ports (Table 1). Nearly 40 percent of U.S. exports entered Mexico via Brownsville, Laredo and Eagle Pass, Texas while the remaining overland exports (7 percent) were via the western district (El Paso, Texas; Nogales, Arizona and Calexico, California).
To evaluate the relative efficiency of the Northeast and Pacific-North systems in transporting U.S. grain/soybeans from border-crossing locations to Central Mexico, rail distances from Omaha, Nebraska to Mexico City and Guadalajara were estimated via border locations served by the Northeast (Laredo, Brownsville) and Pacific-North (Eagle Pass, El Paso, Nogales, Calexico) systems (Table 2). Omaha served as a representative origin since it is located in a region that ships corn/soybeans/grain sorghum to border locations; Mexico City and Guadalajara were selected because of their location in Central Mexico, a region which includes nearly half of Mexico’s excess grain demands. The exercise shows the shortest distance to Central Mexico is associated with routing over the Laredo, Texas crossing, a location served by the Northeast system. This route is about 130 miles shorter than the route through Eagle Pass (Pacific-North system). About 100 of the 130 mile advantage is a result of the Northeast’s shorter Laredo-Mexico City and Laredo-Guadalajara routes. Trackage rights as specified by the government of Mexico, when dividing the national system into three mainlines, appear to have been designed to foster intramodal competition. For example, if the Pacific-North had no trackage rights on the Northeast system, the routing from Eagle Pass to Mexico City and Guadalajara would increase about 350 and 260 miles, respectively, and the Northeast system would have no access to the Guadalajara market.

Intermodal competition, as provided by ship/truck and ship/rail combinations, would also seem likely for the Mexico mainlines in the Central Mexico market. Veracruz, a major grain port on the Mexican Gulf, is about 240 miles from Mexico City; Veracruz and Mexico City are linked by two mainlines (Southeast, Northeast) and motor carriage, thus potential ship/rail and ship/truck competition. Further, intermodal competition would appear to influence the overland carriers in the Guadalajara market where Pacific-North and motor carriers link the port at Manzanillo to Guadalajara (220 miles).

MODEL, PROCEDURE, AND DATA

Analysis was accomplished with spatial, intertemporal equilibrium models of the international corn, sorghum and soybean sectors. The models are specified as quadratic programming models of the type developed by Takayama and Judge (1971). These models generate interregional flow patterns that result from maximizing producer plus consumer surplus minus grain handling, storage and transportation costs. The international models include considerable detail on regional excess supplies/demands and linking transportation/logistics costs/rates in the United States and Mexico; other trading countries are more simply represented as an excess supply or excess demand region. The developed models in combination with a heuristic procedure that systematically adjusts rates on Mexican rail transportation arcs is used to determine the profit-maximizing rail rate structure and associated flow patterns that are likely to evolve with privatization of Mexico’s rail system. Variable costs represent a lower bound estimate of rates on Mexican rail transportation arcs while the upper bound is determined by intermodal/intramodal competition.
Model

The following is a mathematical representation of the developed corn, sorghum and soybean models under the assumption of linear excess demand/supply relationships (Takayama and Judge: Samuelson). Equation 1 is the objective function which is maximized subject to constraints 2 through 13. See Table 3 for definition of subscripts, parameters and variables included in the following equations:

\[
(1) \quad \text{Maximize } Z = \sum_{q} \left\{ - \sum_{i} (\alpha_{iq} + 0.5 \beta_{iq} S_{iq}) S_{iq} - \sum_{f} (\alpha_{fq} + 0.5 \beta_{fq} S_{fq}) S_{fq} \right. \\
- \sum_{r} (\alpha_{rq} + 0.5 \beta_{rq} S_{rq}) S_{rq} \\
+ \sum_{j} (\alpha_{jq} - 0.5 \beta_{jq} D_{jq}) D_{jq} + \sum_{d} (\alpha_{dq} - 0.5 \beta_{dq} D_{dq}) D_{dq} \\
+ \sum_{h} (\alpha_{hq} - 0.5 \beta_{hq} D_{hq}) D_{hq} \\
- \left\{ \sum_{m} \left( \sum_{i} C_{ijm} T_{ijqm} + \sum_{j} C_{ijm} T_{ijqm} + \sum_{p} C_{ipm} T_{ipqm} \right) \right\} \\
+ \sum_{r} \sum_{h} (C_{rhm} T_{rhqm}) + \sum_{j} \sum_{u} (C_{ujm} T_{ujqm}) \\
+ \sum_{w} \sum_{i} (C_{iwm} T_{iwqm} + C_{whm} T_{whqm}) \\
- \sum_{b} \sum_{u} (C_{bu} T_{buq} + \sum_{p} C_{bp} T_{bpq}) \right. \\
\]

4
\[-\sum (\sum_{p} C_{pdq} T_{pdq} + \sum_{f} C_{fdq} T_{fdq})
\]
\[-\sum_{p} \sum_{x} C_{pxq} T_{pxq} \sum_{f} \sum_{x} C_{fxq} T_{fxq} - \sum_{x} \sum_{h} C_{xhm} T_{xhmq} - K_{us} (\sum_{q+1} \sum_{i} G_{iqqq+1})
\]
\[-K_{max} (\sum_{qq+1} \sum_{i} G_{iqqq+1})
\]

subject to:

(2) \(\sum_{m} (\sum_{j} T_{ijqm} + \sum_{b} T_{ibqm} + \sum_{p} T_{ipqm}) + G_{iqqq+1} \leq S_{iq} + G_{iq-1q} \) for all \(i, q\);

(3) \(\sum_{m} (\sum_{h} T_{rhqm}) + G_{iqqq+1} \leq S_{rq} + G_{q-1q} \) for all \(r, q\);

(4) \(\sum_{p} T_{bpq} + \sum_{u} T_{buq} \leq \sum_{m} \sum_{i} T_{ibqm} \) for all \(b \) and \(q\);

(5) \(\sum_{j} \sum_{m} T_{ujqm} \leq \sum_{u} T_{buq} \) for all \(u \) and \(q\);

(6) \(\sum_{h} \sum_{m} T_{whmq} \leq \sum_{i} \sum_{m} T_{iwmq} \) for all \(w \) and \(q\).

(7) \(\sum_{d} T_{pdq} + \sum_{x} T_{pxq} \leq \sum_{m} \sum_{i} T_{ipmq} + \sum_{b} T_{bpq} \) for all \(p \) and \(q\);

(8) \(\sum_{m} (\sum_{i} T_{ijmq} + \sum_{u} T_{ujmq}) \geq D_{jq} \) for all \(j \) and \(q\);

(9) \(\sum_{m} \sum_{h} T_{xhmq} \leq \sum_{p} T_{pxq} + \sum_{f} T_{fxq} \)
\begin{align}
(10) \quad & \sum_{p} T_{pdq} + \sum_{f} T_{f\bar{d}q} \geq D_{dq} \quad \text{for all } d \text{ and } q; \\
(11) \quad & \sum_{d} T_{fq\bar{d}} + \sum_{x} T_{f\bar{x}q} + R_{qq^{-1}} \leq S_{fq} + R_{qq^{-1}} \quad \text{for all } f \text{ and } q; \\
(12) \quad & \sum_{m} \left( (\sum_{w} T_{whmq}) + (\sum_{x} T_{xhmq}) + (\sum_{r} T_{rhmq}) \right) \geq D_{hq} \quad \text{for all } h \text{ and } q. \\
(13) \quad & T, S, D \geq 0 \quad \text{for all } i, j, f, q, d, b, u, p, r, h, x \text{ and } w.
\end{align}

The objective function (1) maximizes net social payoff or consumer plus producer surplus minus grain handling, storage and transportation costs. Equation 2 constrains the quantity of grain shipped from each U.S. supply region to all receiving and transshipment points in each quarter to be less than or equal to the quantity supplied or carried-over by the supply region. Similarly, Equation 3 constrains quantity of grain shipped from each Mexico supply region to all receiving and transshipment locations in each quarter to be less than or equal to quantity supplied or carried over. Equation 4 constrains the quantity of grain shipped from a barge-loading location in each quarter to be less than or equal to the total quantity received from all supply regions. Equation 5 balances the inflow and outflow of grain at each barge unloading location in each quarter while equation 6 balances intercountry flows at each U.S./Mexico border crossing location. Equation 7 balances the inflow and outflow of grain at each U.S. port in each quarter. Equation 8 constrains quantity shipped by all inland transportation modes to each domestic demand region to be at least equal to or greater than the quantity demanded at each U.S. demand region in each quarter. Equation 9 requires that shipments from Mexican ports to Mexican demand regions be less than or equal to inflows at Mexican ports. Equation 10 forces the quantity of grain received by each foreign demand region to be equal to or greater than the quantity demanded by each foreign demand location in each quarter. Equation 11 constrains quantity of grain shipped by each foreign excess supply region in each quarter to be less than or equal to the quantity supplied or carried over by the foreign excess supply region. Equation 12 forces quantity shipped by all inland transportation modes to each Mexico demand region to be equal to or greater than quantity demanded and equation 13 includes the non-negativity conditions.

The international corn model includes forty-eight U.S. excess demand regions, nineteen Mexico excess demand regions, fifty-eight U.S. excess supply regions, nineteen Mexico excess supply regions, seventeen U.S. ports, eight Mexico ports, twenty-five foreign excess demand regions and five foreign excess supply regions. Thirty-seven barge loading sites are included on the Mississippi and Ohio River systems and tributaries. The seventeen port areas include two Atlantic ports, five Gulf ports, five Pacific ports, four Great Lakes ports and a port near Quebec, Canada which can serve as a transshipment location for grain exiting the Great Lakes. To reflect freezing of the Great Lakes and upper Mississippi waterways, the models disallow shipping via these arteries.
in the winter quarter. The five major U.S.-Mexico inland crossing locations are included as are five Mexican ports in the Gulf and three in the Pacific. The U.S. excess supply and excess demand regions are linked by truck, railroad and barge transportation costs while U.S. ports and foreign excess supply regions are linked to foreign excess demand regions and Mexico ports by ship rates. Mexico excess supply and demand regions are linked by truck and railroad costs/rates as are Mexican ports and Mexico excess demand regions. Grain handling and storage costs are incurred in United States, Mexico and foreign excess supply regions; handling costs (loading/unloading) are incurred at barge loading and unloading locations and U.S. ports while inspection fees and interlining costs are incurred at U.S.-Mexico border crossing sites. Each model includes four quarters and represents a commodity’s crop year. Crop years for corn, sorghum and soybeans extend from October to September.

**Procedure**

The developed corn, soybean and grain sorghum models represent the early 1990’s. To validate these base models, their projected flows were compared to historic flows. In particular, model-projected exports via U.S. port areas were compared with historic export levels while Mexico’s historic imports via border-crossing locations and marine ports were contrasted with model-projected values. The USDA’s *Feed Grain and Market News* provided data on U.S. exports by port area while Klindworth and Martinsen (1995) was a source for similar information on Mexico’s import flows. Historic flows were within 4 percent of model-projected flows for all major U.S. port areas and within the historic range for Mexico’s imports. Since model-projected flows closely approximated historic flows, the models were judged to be adequate for purposes of carrying out study objectives.

To accomplish study objectives, a heuristic method was developed to estimate profit-maximizing rates on routes to be served by the three mainline companies. The procedure is similar to that used to project regional railroad rates *ex post* railroad deregulation (Fuller, Makus and Taylor). The heuristic method assumes the lowest rate on any route would be the variable cost of the privatized railroad and the highest rate would be that permitted by intermodal/intramodal competition. The heuristic method involves replacing the FNM rate structure in each model with estimated variable costs and then solving the models to determine the selected transportation mode(s) serving Mexico’s nineteen excess demand regions and the associated dual/shadow prices. The dual/shadow price measures the extent to which the selected mode (railroad) on a particular route could increase its rate above variable cost without diverting traffic to a competitor. The dual/shadow price serves as a guide to the minimum increase or markup over variable costs that could be charged by a privatized rail carrier. To determine the profitability of increasing the markup above the dual/shadow price, model solutions were obtained that involved a series of elevated rates on the rail arcs in question. That railroad rate which generated the greatest net cash flow (total revenue minus total variable cost) was identified as the profit-maximizing rate for that particular route. The procedure assumes Mexico’s oligopolistic railroad industry would be competitive, i.e., no pricing coordination would come to exist. This seemed reasonable in view of Mexico’s proposed regulatory scheme.
To evaluate the effect of privatizing Mexico’s railroad industry on U.S./Mexico overland grain/soybean trade, base model solutions are contrasted with solutions that reflect profit-maximizing railroad rates under privatization. The solutions focus on flows via overland crossings and producer welfare in the U.S. and Mexico.

Data

To estimate the developed spatial models it was necessary to estimate domestic, Mexico and foreign excess supply/demand equations; grain handling and storage costs; rail, truck, barge and ship costs/rates and obtain applicable grain/soybean subsidies, tariffs and quotas.

The domestic and Mexico regional short-run excess supply equations were derived from an estimated regional excess supply elasticity, regional exports and price while the domestic and Mexico excess demand equations were obtained from the estimated regional excess demand elasticity, regional imports and prices. The excess supply/demand equations were based on formulas by Kreinin (1983) and Shei and Thompson (1977).

\[ E_{es} = \frac{Q_d}{Q_e} \mid E_d \mid \]

\[ E_{ed} = \frac{Q_d}{Q_i} E_d \]

where,

\[ E_{es} = \text{excess supply elasticity of region} \]
\[ E_{ed} = \text{excess demand elasticity of region} \]
\[ Q_d = \text{quantity demanded or consumed in region} \]
\[ Q_e = \text{quantity exported from region} \]
\[ Q_i = \text{quantity imported into region} \]
\[ E_d = \text{own-price demand elasticity} \]

Domestic and Mexico demand elasticities were taken from Sullivan, Roningen, Leetmaa and Gray (1992). Crop production in the United States by crop reporting district was made available by the Agricultural Statistical Service and regional prices were taken from the USDA’s Agricultural Prices. Estimates of consumption or demand were necessary to estimate excess supply and demand since production and consumption are subtracted to determine whether the region is an importer or exporter.
Regional sorghum/corn consumption by dairy/livestock/poultry in the United States were obtained with estimates of regional populations and rations. Regional population data were taken from *Cattle, Layers and Egg Production, Poultry Production and Value, Hogs and Pigs, and Cattle on Feed* while ration information came from *Livestock-Feed Relationship, National and State* and animal/poultry nutritionist.

Estimates of industrial corn, sorghum and soybean demands were based on data provided by the U.S. Departments of Agriculture, Commerce, and Treasury, and information from trade sources. The 1992 *Milling Directory* was a source of corn processing capacity and in combination with national estimates of milled corn output was used to make estimates of regional consumption (*USDA, Feed Situation and Outlook Report*). The Department of Energy provided information on ethanol plants and capacities; this information was used in combination with national output data to estimate regional corn/sorghum consumption by ethanol processors. Regional corn/sorghum consumption by breweries and distilleries was provided by the Department of Treasury. Soybean processing demands were estimated with capacity information from the National Oilseed Processors Association, and data from *Fats and Oils: Oilseed Crushings and Oil Crops Yearbook*.

Regional grain/soybean production and demand data for Mexico came from *Estimated Regional Production/Consumption of Corn, Wheat, Sorghum and Soybeans in Mexico*. The state-level estimates of demand included projected consumption by the livestock/poultry/dairy sectors and industrial demands. Regional prices in Mexico were imputed from U.S. Census data that related quantity and value of U.S. exports to Mexico by border crossing location and marine port and with estimated transportation/handling costs associated with moving grain/soybeans from U.S. export sites to Mexican demand regions.

The barge, railroad and truck cost parameters included in the U.S. portion of the model were estimated with costing codes from Reebie Associates. The estimated cost parameters were compared with actual rates or other cost estimates to determine their appropriateness. To determine reasonableness of barge cost parameters, actual rates from St. Paul, Minnesota; Peoria, Illinois and St. Louis, Missouri to the lower Mississippi River port area were compared with historical rates. In all cases, the historical average rate differed from estimated cost by less than 8 percent. Estimated rail cost parameters were statistically compared with rates from the Public Use Waybill to determine their comparability. Although the average per ton cost estimate was about 8 percent greater than rates ($1.80/ton), the analysis of variance failed to reject the hypothesis that mean rail rates equaled the estimated mean rail cost on the analyzed corridors. Trucking costs reflected five axle, 42 foot hopper trailers carrying 25 tons of grain; the average cost of this configuration was estimated to be $1.13/mile. This cost parameter was compared with a time-adjusted estimate from Dooley, Bertram and Wilson (1988) and was found similar. Ship rates linking U.S. ports with Mexican ports and ports of foreign excess demand regions, and ship rates linking foreign excess supply regions with Mexican ports and foreign excess demand regions came from an estimated regression model which was based on data taken from *Chartering Annual* (Fellin and Fuller).
Grain receiving, loading and storage costs for U.S. country elevators, inland terminals and port terminals were based on a national survey of grain handlers. Mexican grain handling and storage costs were based on communications with Boruconsa and Bodegas Rurales Conasupo which are Mexican government agencies involved with grain assembly and storage. Port discharge costs in Mexico came from Klindworth and Martinsen (1995) and varied by port area.

The FNM grain/soybean rates included in the base models came from El Costo Y La Competitividad Del Transporte Ferroviario De Granos Y Oleaginosas. These rates differed by commodity and were directly related to distance. Because the FNM failed to provide service on some routes where their rates were lower than truck competition, it was necessary to constrain selected rail-carried movements in the base models; historic truck/rail flows found in Klindworth and Martinsen (1995) provided information on these constraints. In the privatization scenario it was assumed that rail carriers would serve shippers/receivers on routes where their rates exceeded variable costs and were lower than competition.

Mexican grain trucking rates came from El Costo Y La Competitividad Del Transporte Ferroviario De Granos Y Oleaginosas. The per mile grain trucking rates in Mexico averaged about 25 percent higher than the United States. Higher interest rates and truck repair costs in Mexico tend to more than offset the lower wages paid to Mexican drivers.

Based on a comparison between estimated U.S. carrier costs and projected costs of a privatized Mexican railroad, it seemed reasonable to assume that costs of the privatized mainlines in Mexico would come to approximate that of U.S. carriers. Estimated costs of a privatized Mexican railroad system came from El Costo Y La Competitividad Del Transporte Ferroviario De Granos Y Oleaginosas and were based on the assumption that labor/capital would be purchased at market-determined rates, the FNM labor force would be reduced by 50 percent, the peso exchange rate would not be distorted and imports of locomotives and railcars would not be subject to tariffs. The assumptions seemed reasonable in view of recent articles which indicate the Mexican government may use revenues obtained from privatization to make severance payments to about half the FNM workers (Burke, March 25, 1996). Privatization is expected to reduce the FNM’s bloated labor force of 49,000 to about 24,000 (Hall, June 18, 1996). Further, the TFM has reported intentions to invest $945 million in capital improvements for purposes of lowering operating costs (Burke, March 17, 1997). Based on the above assumptions, a variable cost of $0.0268 per metric ton-mile was projected for a privatized Mexican carrier when transporting grain over a 420 mile haul. To determine the comparability of the projected cost parameter with costs of an average U.S. carrier, the Reebe rail cost code was used to estimate variable costs for a single-car, covered hopper (89 metric tons) over a 420 mile distance with a 100 percent empty-return ratio. This analysis produced a variable cost of $0.0270 per metric-ton mile, a value near that projected by the Mexican study. For these reasons, it seemed reasonable to assume that variable costs of a privatized Mexican carrier may come to approximate that of U.S. carriers, thus the appropriateness of using the Reebe rail cost code to estimate variable rail costs of privatized carriers in Mexico.
The Reebie rail costing code in combination with haul characteristics and average car weights presented in Klindworth and Martinsen (1995) and as revealed by FNM waybill data were used to estimate variable costs on various routes. Costs for transporting soybeans from U.S./Mexico border locations to Mexican demand centers were based on a 50-car shipment with an average hopper car net weight of 77 metric tons. In contrast, corn and sorghum costs were based on a 12-car shipment and an average hopper net weight of 77 metric tons. Mexican waybill data indicated 50-foot boxcars dominate on rail movements from marine port areas and other intracountry movements. Thus, these costs reflect single car movements of 50-foot boxcars carrying 54 metric tons. All trackage right grants included in the privatization process were costed to users at $0.0033/metric ton-mile.

The excess supply/demand relationships for foreign exporters and importers were derived from an excess supply (demand) elasticity, and information on quantity exported (imported) and price. The short-run excess supply/demand elasticities were obtained from formulations similar to those used to estimate domestic excess supply/demand elasticities (Shei and Thompson; Kreinin).

\[ E_{es} = \frac{Q_p}{Q_e} \left| E_d \right| \]

\[ E_{ed} = \frac{Q_d}{Q_i E_d} \]

where,

\[ E_e = \text{excess supply elasticity of foreign supplier} \]

\[ E_d = \text{excess demand elasticity of foreign importer} \]

\[ Q_p = \text{quantity produced by foreign supplier} \]

\[ Q_e = \text{quantity exported by foreign supplier} \]

\[ Q_d = \text{quantity demanded or consumed by foreign importer} \]

\[ Q_i = \text{quantity imported by foreign importer} \]

\[ E_d = \text{own-price demand elasticity of foreign supplier/importer} \]

The own-price demand elasticities of foreign suppliers/importers were taken from Sullivan, Roningen, Leetmaa and Gray (1992). Production, prices, exports and imports were from World Grain Situation and Outlook, World Oilseed Situation and Market Highlights and the Production, Supply and Distribution (PS&D) database.
RESULTS

The effect of privatizing the state-owned railroad of Mexico on U.S. overland exports of grain/soybeans to Mexico is evaluated for sorghum, soybean and corn.

Grain Sorghum

The base solution (pre-privatization) shows U.S. sorghum exports to Mexico of 3.575 million metric tons (mmt) with 1.808 mmt entering Mexico via overland routes and the remaining 1.767 mmt entering through Mexico’s port system (Table 4). Mexico maritime imports (1.767 mmt) enter via ports at Veracruz, Tuxpan, Coatzacoalcos, Manzanillo, Guaymas and Progresso. Of the 1.808 mmt imported by Mexico via overland routes, an estimated 1.063 mmt is rail-carried by FNM and the remaining 0.745 mmt transported by truck. About 80 percent of the grain sorghum carried into Mexico by truck originates in U.S. supply regions that ship by railroad to south Texas border locations where intermodal transfer is accomplished. Virtually all of the rail-carried sorghum originates in Texas and Kansas and enters through the Brownsville, Laredo and Eagle Pass, Texas crossing locations.

Privatization of the Mexican railroad system is projected to have an important affect on U.S./Mexico sorghum trade. The short-run analysis projects only a modest increase in Mexico imports (3 percent), but a dramatic increase in overland imports. Imports via border locations are projected to increase from 1.808 mmt to 2.806 mmt, while imports via marine ports decline from 1.767 to 0.876 mmt. A corresponding reduction in U.S. sorghum exports via lower Mississippi River, Texas and Pacific Northwest ports is projected; remaining marine imports by Mexico enter via ports at Veracruz, Guaymas and Progresso. Mexico’s imports of rail-carried sorghum are projected to increase from 1.063 mmt to 2.698 mmt, an increase of 1.635 mmt. This increase results from additional quantities (0.998 mmt) that move by rail from U.S. excess supply regions in Texas, Kansas, and Nebraska to border locations and the diversion of 0.637 mmt from Mexican truck to privatized rail carrier. The analysis estimates privatization of Mexico’s railroad system will increase U.S. sorghum producers revenues $13.2 million while reducing Mexican producers revenues $2.8 million.

The Northeast railroad is projected to transport 1.876 mmt of sorghum from border crossing locations to Mexico demand centers with an estimated 1.331 mmt moving via the Laredo gateway and the remaining (0.545 mmt) crossing at Brownsville. The grain is routed to demand centers in the states of Mexico, Puebla, Hidalgo, Queretaro, San Luis Potosi, Aguascalientes, Nuevo Leon, and Jalisco. In addition, the Northeast railroad is projected to transport 0.267 mmt from the port at Veracruz to demand locations in Central Mexico. The Northeast system is projected to generate $16.74 million above variable cost on sorghum haulage yielding a weighted average revenue-to-variable cost ratio of 1.54.
The Pacific-North transports an estimated 0.822 mmt of U.S. sorghum via crossings at Eagle Pass (0.723) and El Paso (0.095) to demand centers in Guanajuato, Durango, Zacatecas, Coahuila and Chihuahua. In addition, the Pacific-North is projected to carry (0.218 mmt) U.S. sorghum from Pacific ports (Manzanillo, Guaymas) to demand centers in Sonora and Sinaloa. A weighted average revenue-to-variable cost ratio of 1.70 is projected for the Pacific-North system on sorghum traffic; in addition, revenues in excess of variable cost are generated that equal $8.48 million.

**Soybeans**

The base solution (pre-privatization) shows U.S. soybean exports to Mexico of 1.802 mmt with 0.957 mmt entering that country through overland crossings while the remaining 0.845 mmt arrives via ports at Veracruz, Coatzacoalcos, Manzanillo, Guaymas and Progresso (Table 4). Of the 0.957 mmt that enters by overland crossing, about 0.833 mmt is rail-carried by FNM to Mexican demand centers; these soybeans originate in Texas, Kansas, Nebraska and Arkansas and are transported by U.S. railroads to border crossings at Laredo, Brownsville, Eagle Pass, El Paso and Nogales. Remaining Mexican overland imports (0.124 mmt) are carried by Mexican truck from south Texas production regions.

The analysis projects privatization of the Mexico railroad system will modestly increase (3 percent) U.S. exports of soybeans but substantially increase overland trade. Overland exports to Mexico are projected to increase from 0.957 mmt to 1.660 mmt; *ex ante* privatization, 0.833 mmt enter Mexico by FNM whereas, *ex post* privatization, an estimated 1.536 mmt enter by railroad. Mexican trucks continue to transport 0.124 mmt from south Texas production locations to Mexican demand centers. All additional overland flows to border locations originate in Nebraska, Missouri and Kansas and are rail-transported. Mexico soybean imports via its port system are projected to decline from 0.845 mmt to 0.194 mmt; remaining maritime imports enter at Veracruz and Progresso. Mexico’s reduced maritime imports correspond directly to lowered U.S. exports at Texas and lower Mississippi River ports.

The Northeast system is projected to transport 1.165 mmt of soybeans from the Laredo/Brownsville crossings to demand centers located in Mexico, Puebla, Queretaro, Hidalgo, San Luis Potosi, Nuevo Leon and Jalisco. Revenue in excess of variable cost is projected at $2.718 million on soybean haulage: the associated weighted average revenue-to-variable cost ratio on this haulage is 1.17. A projected 0.375 mmt is carried by the Pacific-North from border crossings at El Paso, Nogales and Eagle Pass to demand locations in Sinaloa, Sonora, Durango, Zacatecas, Guanajuato and Tamaulipas. The Pacific-North earns revenues in excess of variable costs equal to $1.115 million and generates a weighted average revenue-to-variable cost ratio of 1.27.

**Corn**

The base solution (pre-privatization) shows U.S. corn exports to Mexico of 2.201 million metric tons (mmt) with 0.735 mmt entering Mexico via overland routes and the remaining 1.466 mmt entering through its marine port system (Table 4). An estimated 0.644 mmt enters Mexico via
the FNM gateways at Laredo, Brownsville and El Paso; the remaining 0.090 mmt of Mexico’s overland imports are carried by Mexican trucks. Mexico’s marine imports enter at Veracruz, Coatzacoalcos, Manzanillo and Progresso.

Historic flow data and the base model solution show most U.S. corn exports to Mexico are transported via ocean routings. This routing is expected since the majority of U.S. corn exports exit important U.S. surplus regions (Iowa, Illinois, Minnesota) via low-cost barge transportation for purposes of moving to lower Mississippi River ports for export. Thus, the least-cost supply of U.S. corn for Mexico involves barge transportation over the Mississippi River system with subsequent ocean transportation to Mexico ports. Accordingly, the U.S. has historically exported comparatively modest quantities to Mexico via overland routes. In the base solution, most U.S. corn moving to border locations originate in southeast Nebraska and Iowa. Excess corn supplies in the western Corn Belt (Nebraska, Iowa, Missouri) are potential sources of additional supplies for overland export to Mexico but strong export competition via Pacific Northwest ports and livestock/poultry/dairy demands in the U.S. west and southwest offer strong competition to overland corn exports to Mexico. Thus, the geographic location of the U.S. corn demands/supplies and the U.S. barge transportation system may have important implications for additional overland haulage of corn to Mexico.

Results suggest privatization of Mexico’s railroad system would dramatically increase overland corn imports in spite of potential limitations in the availability of nearby U.S. corn supply. In particular, overland rail-carried corn exports to Mexico border locations are projected to increase from 0.735 mmt to 1.967 mmt while marine exports decline from 1.466 mmt to 0.440 mmt; the effect of privatization is to increase U.S. corn exports to Mexico from 2.201 to 2.407 mmt. The corn model shows additional quantities routed to border locations from Nebraska, Missouri, Iowa and South Dakota, while correspondingly smaller quantities are routed to Texas and Pacific Northwest ports. Mexico’s marine imports are restricted to Veracruz, Guaymas and Progresso ex post privatization.

The Northeast system is projected to carry 1.743 mmt of corn from Laredo and Brownsville gateways to Mexico demand centers in Mexico, Puebla, Tlaxcala, Hidalgo, Queretaro, Jalisco, San Luis Potosi, and Nuevo Leon. In addition, the Northeast is projected to transport 0.120 mmt from the port at Veracruz to demand centers in Central Mexico. Based on the analysis, the railroad would generate revenue in excess of variable costs equal to $7.59 million; the associated average weighted revenue-to-variable cost ratio on corn haulage is 1.33. The Pacific-North is projected to transport 0.224 mmt from El Paso and Eagle Pass crossing locations to demand centers in Chihuahua, Coahuila, Durango and Zacatecas. An estimated $0.965 million is earned in excess of variable cost on corn haulage to yield a revenue-to-variable cost ratio of 1.58.
SUMMARY

The objective of this study was to determine whether privatization of Mexico’s state-owned railroad would have unfavorable implications for U.S. overland grain/soybean exports to Mexico. *Ex post* privatization, railroad costs and demands and intramodal and intermodal competition will become important determiners of transportation rates. Thus, rates are likely to change and because grain is a low-valued, bulky commodity whose geographic flow pattern is sensitive to transportation costs, privatization may be disruptive to U.S. overland grain exports to Mexico.

The study focuses on U.S. sorghum, soybean, and corn exports; analysis is accomplished with spatial models of these sectors. A heuristic procedure is followed with the spatial models for purposes of determining the profit-maximizing rates likely to be charged by a privatized railroad in the various Mexican transportation markets. The analysis assumes that costs of the privatized Mexican railroads will come to approximate that of the average U.S. carrier.

Results suggest privatization of the Mexican railroad system has the potential to dramatically increase U.S. grain/soybean exports to Mexico via overland routes. Pre-privatization analysis show U.S. overland exports to Mexico of 3.50 mmt; U.S. rail carriers are projected to carry 3.144 mmt to border locations with the FNM and Mexican truckers transporting 2.540 and 0.96 mmt, respectively, to Mexican demand centers. The post-privatization analysis shows U.S. grain/soybean overland exports to Mexico increase to 6.433 mmt, an increase of 2.933 mmt over the pre-privatization scenario. Railroads in the U.S. transport an estimated 6.201 mmt to border locations where all is transferred to the privatized Mexican railroads for delivery into Mexico. The Northeast system is projected to transport over three-fourths of the overland exports to Mexican destinations.

The projected increase in U.S. overland grain/soybean exports to Mexico result from significant reductions in the railroad costs of privatized carriers and the competitive transportation environment that allow rail carriers to only modestly increase rates above variable costs. For example, under the FNM rate structure, rates for feedgrain movements from U.S. border crossing sites to Central Mexico ranged from $24 to $27/ton, whereas under privatization the rate is projected to decline to about $19 per ton and carriers are expected to generate a revenue-to-variable cost ratio on this haulage of about 1.2. Railroad rates are constrained by intramodal competition on many important routes because of trackage rights specified by the government of Mexico in the privatization process. In addition, intermodal competition, as offered by ship/truck and ship/rail combinations provide important competition to rail carriers in selected Mexican grain/soybean markets.

In summary, privatization of Mexico’s railroad system has the potential to dramatically increase U.S. overland exports of grain/soybeans to Mexico. Thus, concern that privatization of Mexican railroads will hinder U.S. agriculture’s ability to compete in the Mexican grain/soybean markets is unwarranted; in fact, the analysis shows U.S. producers annual grain/soybean revenues may increase $42 million per year as a result of privatization.
Table 1: Mexican Grain Imports, Percentages by Route and Port Range, 1990-94

<table>
<thead>
<tr>
<th>Route/Port/Year</th>
<th>1990</th>
<th>1991</th>
<th>1992</th>
<th>1993</th>
<th>1994</th>
<th>Average</th>
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<tbody>
<tr>
<td>Overland:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laredo District</td>
<td>24</td>
<td>39</td>
<td>36</td>
<td>47</td>
<td>44</td>
<td>38</td>
</tr>
<tr>
<td>Western Border</td>
<td>7</td>
<td>4</td>
<td>7</td>
<td>9</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Subtotal</td>
<td>32</td>
<td>43</td>
<td>42</td>
<td>56</td>
<td>50</td>
<td>45</td>
</tr>
<tr>
<td>Maritime:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maritime/Gulf</td>
<td>55</td>
<td>46</td>
<td>42</td>
<td>36</td>
<td>41</td>
<td>44</td>
</tr>
<tr>
<td>Maritime/Pacific</td>
<td>13</td>
<td>11</td>
<td>15</td>
<td>8</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Subtotal</td>
<td>68</td>
<td>57</td>
<td>58</td>
<td>44</td>
<td>50</td>
<td>55</td>
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<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Klindworth and Martinsen

Table 2: Estimated Distance from Omaha, Nebraska to Mexico City and Guadalajara, Mexico via Border Crossing Sites served by Northeast and Pacific-North Systems

<table>
<thead>
<tr>
<th>Border Crossing Sites</th>
<th>Mexico City (miles)</th>
<th>Guadalajara (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brownsville/Matamoros⁠¹</td>
<td>2056</td>
<td>2115</td>
</tr>
<tr>
<td>Laredo/Nuevo Laredo⁠¹</td>
<td>1870</td>
<td>1929</td>
</tr>
<tr>
<td>Pacific-North System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eagle Pass/Piedras Negras²</td>
<td>2001</td>
<td>2060</td>
</tr>
<tr>
<td>El Paso/CD. Jarez²</td>
<td>2424</td>
<td>2366</td>
</tr>
<tr>
<td>Nogales/Nogales²</td>
<td>2993</td>
<td>2616</td>
</tr>
</tbody>
</table>

¹ Border-crossing sites served by Northeast system.
² Border-crossing sites served by Pacific-North system.
### Table 3: Subscripts, Parameters and Variables Included in Formulated Models

#### Subscripts:
- **q**: quarter (1, 2, 3, 4)
- **i**: U.S. excess supply regions ($i = 1, 2, 3, \ldots, m$)
- **r**: Mexico excess supply regions ($r = 1, 2, 3, \ldots, m$)
- **f**: Foreign exporting regions ($f = 1, 2, 3, 4, m$)
- **j**: U.S. excess demand locations ($j = 1, 2, 3, \ldots, m$)
- **h**: Mexico excess demand regions ($h = 1, 2, 3, \ldots, m$)
- **d**: Foreign importing regions ($d = 1, 2, 3, \ldots, m$)
- **m**: Inland modes of transportation ($m = 1, 2, 3$)
- **b**: Barge loading locations ($b = 1, 2, 3, \ldots, 37$)
- **u**: Barge unloading locations ($u = 1, 2, 3, \ldots, 5$)
- **p**: U.S. ports ($p = 1, 2, 3, \ldots, 17$)
- **w**: U.S.-Mexico border crossing locations ($w = 1, 2, 3, \ldots, 5$)
- **x**: Mexico ports ($x = 1, 2, 3, \ldots, 5$)

#### Parameters:
- **C**: Transportation and grain handling cost per metric ton for truck, railroad, barge and ship modes as appropriate
- **$K_{us}$**: storage cost per metric ton in U.S.
- **$K_{mex}$**: storage cost per metric ton in Mexico
- **$\alpha$**: intercept of linear demand and supply functions
- **$\beta$**: slope of linear demand and supply functions

#### Variables:
- **$S_i$**: U.S. excess supply regions
- **$S_r$**: Mexico excess supply regions
- **$S_f$**: Foreign excess supply regions
- **$D_j$**: U.S. excess demand regions
- **$D_h$**: Mexico excess demand regions
- **$D_d$**: Foreign excess demand regions
- **$T$**: Grain flow in metric tons between nodes
- **$G$**: Quantities of grain stored in the United States per quarter
- **$Z$**: Quantities of grain stored in other major exporting countries per quarter
Table 4: Estimated U.S. Exports of Grain/Soybeans to Mexico Under Pre- and Post-Privatization Scenarios with Associated Changes in Producers Revenues

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Border Crossings</th>
<th>Total U.S. Exports</th>
<th>Changes in Producers Revenues</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-privatization</td>
<td>Post-privatization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Railroad (mmt)</td>
<td>Truck (mmt)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Railroad (mmt)</td>
<td>Truck (mmt)</td>
</tr>
<tr>
<td>Sorghum</td>
<td>1.063</td>
<td>0.745</td>
<td>2.698</td>
</tr>
<tr>
<td>Soybeans</td>
<td>0.833</td>
<td>0.124</td>
<td>1.536</td>
</tr>
<tr>
<td>Corn</td>
<td>0.644</td>
<td>0.091</td>
<td>1.967</td>
</tr>
</tbody>
</table>
REFERENCES


