The Effects of Border Violence on U.S.-Mexican Cattle Trade

Subject Area: U.S. Agricultural Trade

Hannah Ahn

Graduate Research Assistant

Pennsylvania State University

1335 Dreibelbis Street #429B State College, PA 16801

734-277-5920

hannah.hs.ahn@gmail.com

Luis A. Ribera

Associate Professor and Extension Economist

Texas A&M University

Department of Agricultural Economics College Station, TX 77843-2124

979-845-3070

lribera@tamu.edu

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Background

Cattle play a major role in agricultural trade between the United States and Mexico. Since the beginning of NAFTA, the two bordering countries promoted their economic growth and total agricultural trade. However, as much as the regional integration upgraded cooperation, the cattle industry faces several challenges due to violence along the border.

Historically, Mexico has a comparative advantage in the production of feeder cattle, and the United States has a comparative advantage in the production of beef (Peel, Mathews, Johnson 2011). After NAFTA, the United States exported more beef to Mexico and imported more feeder cattle from Mexico (Figure 1). Figure 1 provides monthly data for U.S. imports of Mexican feeder cattle from January 1996 to October 2014. In 2011 and 2012, Mexico's live cattle exports reached about 1.4 million and 1.5 million heads respectively; in 2013, live cattle exports declined to 1.045 million heads.

Based on the data from USDA Market News Service (2014), the percentage of Mexican feeder cattle imports changed over time; most ports of entry show small fluctuations. A high percentage of exports through the Santa Teresa/El Paso ports of entry are present. However, the Presidio port of entry showed a significant decrease in the number of feeder cattle crossings, and the San Luis port of entry became relatively inactive (Table 1).

There are multiple factors influencing the changes of the cattle crossings. According to the literature, i) a seasonal pattern of higher numbers of cattle crossing into the United States between October and May and fewer imports from June to September (Guinn and Skaggs 2005); ii) the combined result of 2010/2011 drought which led to high feed costs in Mexico are other environmental factors (Peel et al. 2010); iii) inspection process that all cattle have to follow the U.S. health regulations before crossing (USDA APHIS 2014); iv) other financial restrictions of fees (Mitchell et al. 2001); v) a policy change in Mexico to increase the slaughter and packing at Federally Inspected Facilities (TIF) and to expand market access into Russia, China, and Singapore (Juan and Williams 2010); and vi) the health and quality of the cattle and breed characteristics (Peel et al. 2010) impact the U.S. cattle imports from Mexico.

Mexican Violence along the Border

Recently, local violence in Mexico and the continuation of safety concerns negatively impact the bilateral trade. The USDA veterinarians are responsible for cattle inspections before cattle cross the border. However, the crimes caused by drug cartels in Mexico have moved its inspection operations to the United States. The crimes also forced the USDA to close down the ports of entry and to establish temporary facilities, which will protect the safety of the US inspectors and maintain the flow of trade across the US border with Mexico.

In March 2012, gang violence caused the closing of U.S. cattle inspection stations in Reynosa, Tamaulipas across from Hidalgo, Texas and Nuevo Laredo, Tamaulipas across from Laredo, Texas for six weeks. This closure was estimated to affect 11 percent of cattle being offered for entry into the United States (Texas Department of Agriculture 2010). Furthermore, the facility in Ojinaga, Chihuahua across Presidio, Texas was closed in August 2012, and it was not reopened until June 23, 2014 (Brezosky 2014). During the closure, a temporary USDA facility in Presidio was opened on October 2, 2012 until the actual port was reopened (Matheis, Garcia, and Halpern 2012). According to Brezosky (2014), Mexican cities across from the Del Rio and Eagle Pass facilities were also closed due to violence since 2010. These events forced Mexican ranchers to transport their animals to the other ports of entry and it could possibly further decrease the exports of feeder cattle to the United States.

Objectives

This research identifies and quantifies the impact of border closures caused by violence that can change the movements of feeder cattle trade between the two countries. This research is determined to explore how border closures influence the trade flows of livestock crossings between the U.S.-Mexico border through different ports of entry from January 2009 to September 2014.

Literature Review

Scholars have attempted to identify the factors affecting the supply of Mexican feeder cattle to the U.S. cattle market. However, relatively few studies on the U.S.-Mexico cattle trade at each port of entry. Mitchell (2000) and Guinn (2005)'s studies the factors that influence feeder cattle movements from Mexico into the United States. Although they did not considered the violence factors, the work of analyzing the relationship between the ports of entry along the border aided addressing questions related to feeder cattle movements between the two countries. Mitchell estimated separate simple regression models for nine live cattle ports of entry (Columbus, Del Rio, Douglas, Eagle Pass, Santa Teresa, Laredo, Nogales, Presidio, and San Luis) along the U.S.-

Mexico border; monthly numbers of live cattle imported at each port served as the dependent variable. Using an ordinary least squares (OLS) method, Mitchell selected the final models based on economic theory, t-statistics, and R^2 (Mitchell 2000). Mitchell found statistically significant rainfall effects and their variability in the rainfall coefficient signs, and significant trend variable in the models. The study provided valuable information predicting the live cattle imports from Mexico into the United States by port of entry using ten major equations. Guinn updated and re-estimated simple regression models developed by Mitchell using step-wise regression procedures with statistical significance set at α=0.10 to evaluate the monthly dummy variables and trend variables. With some monthly variables statistically significant for different models, Guinn found the trend variable to be significant in only two of the nine models, Eagle Pass and Laredo. Furthermore, Guinn evaluated nine regression models that represent the cattle crossings at each port of entry and concluded that the single equation regression models explained at least 54% of the variability in monthly cattle crossings at each port of entry, which are slightly weaker than the explanatory powers of Mitchell's models. Guinn concluded that the greater U.S. cattle prices and the periods of drought, the greater number of cattle imported from Mexico (Guinn 2005). Acknowledging the existence of additional variables that should be incorporated into the port-of-entry explanatory models, the study overall provides insight on some variables affecting the numbers of cattle being traded between the two countries.

Given the limitations of OLS introducing bias in the regression estimates of the values of the coefficients and their standard errors, a simultaneous equations model Seemingly Unrelated Regression (SUR) estimation proposed by Zellner (1962) can be used. Golub and Hsieh (2000) revisited the classical Ricardian model using cross-section seemingly unrelated regressions of sectoral trade flows. They tested the pairs of countries vis-à-vis the United States using three different purchasing power parity exchange rates to determine trade patterns. Golub and Hsieh (2000) found that when the equations were estimated with OLS, the signs and magnitudes of coefficients were similar to those found with SUR, but the t-statistics were always smaller with a few exceptions. On the other hand, the standard errors of the SUR regressions decrease with the number of years used, thereby increasing the t-statistics in the end. Thus, they concluded that the SUR regressions yield more precise estimates in most cases because they make use of more information by estimating the cross-section regressions over several years simultaneously (Golub and Hsieh 2000).

Chionis, Liargovas, and Zanias (2002) expanded the Zellner's SUR estimating the coefficients of the gravity model in order to determine the magnitude of potential trade flows between Greece and nine Balkan countries. The highlight of their research is allowing for correlation between the error terms; the errors of Greece-Germany may be related with the errors of Greece-France (Chionis, Liargovas, and Zanias 2002). Furthermore, they found the SUR estimation was effective in finding potential trades between Greece and the Balkans.

Currently, the OLS and SUR estimations have been widely used to research international and regional integration trade patterns. This study differs from the earlier studies of Mitchell and Guinn because it will use both OLS and SUR to examine the feeder cattle inflow. It will make a comparison of the two techniques. The information in this article had not been observed previously in the extant literature within the topic of bilateral cattle trade at the port of entry level.

Theoretical Framework and Model Specification

This study uses two methods to examine the impact of violence on Mexican feeder cattle imports. Ten econometric models were tested to explain the effect of the border closures on the cattle crossings through different ports of entry along the U.S.-Mexican border: Mexican Feeder Cattle Imports from Santa Teresa, Nogales, Laredo, Eagle Pass, Hidalgo, Douglas, Columbus, Del Rio, Presidio, and San Luis.

OLS procedures were first selected for analyzing live cattle imports from Mexico into the United States concerning the impacts of border closures at each port of entry. Each one of the ten ports had its own unique model to represent its own phenomenon from January 2009 to September 2014. The dependent variable in each model was the total monthly cattle crossings through the selected port of entry; the explanatory variables used in the initial model development and testing were lagged cattle imports; port of entry closures; temporary facility openings; drought; corn price; US feeder steers price; US fed steers price; Mexico feeder steer price; exchange rates; oil price; seasonality; linear trend; and parabolic trend. For example, Santa Teresa port of entry will be measured as:

SantaTeresa = *ƒ* (STlag, Nogales, Laredo, EaglePass, Hildago, Douglas, DelRio, Columbus, Presidio, Plag, SanLuis, Pdummy, Tdummy, Drought, Corn, Usfeeder, Usfed, Mxfeeder, Exchrate, Oil, Trend, Trend2, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov)

Then the other port equations will be modeled using the same explanatory variables except that one explanatory port (independent variable) becomes the explained port (dependent variable) for the next equation. For example, after Santa Teresa modeling, the explained variable SantaTeresa will become the explanatory variable for the other equations; Nogales will become the explained variable for its equations and will be the explanatory variable for the other equations.

Secondly, models are jointly estimated using the SUR estimator. The SUR model is a system of linear equations with error terms that are correlated across equations for a given port of entry. It is hypothesized that the geographical locations of the ports are conceptually related equations; therefore, this study recognizes that there is a potential for correlation between the error terms of the two equations. If the error terms are correlated, the SUR model is an appropriate technique for addressing cross-equation error correlation, and will gain efficiency by using the SUR model. However, if the error terms of these ten models are unrelated, then the OLS regressions will be sufficient.

Data and Method

Monthly data from January 2009 to September 2014 were collected from the World Institute for Strategic Economic Research (WISERTrade). The monthly US cattle imports in dollar value from Mexico’s port of entry data were first extracted. These values were divided by the ratios of the monthly US cattle imports from Mexico’s overall import dollar values and total quantities. So monthly US cattle net quantity imports by port of entry were generated.

Figure 3 shows monthly cattle crossings from January 2009 to September 2014 into the United States for each of the ten ports of entry. Figure 4 gives another representation of the monthly percentages of cattle imports for all ports. Of all the cattle that crossed from Mexico into the United States through the ten ports of entry, Santa Teresa had the largest volume of cattle entries at 35%. Nogales was the second largest port of entry for cattle imports at 15%, and Presidio was the third largest port of entry at 11%.

The cattle trade faced the anomaly of a severe drought in 2010 and 2011 that forced Mexican cattle ranchers to liquidate their herds earlier than normal. These similar patterns were presented at each of the ten ports of entry. So Texas's drought data were collected from the United States Drought Monitor to examine their influences and was used as proxy for northern Mexico. Those data provided weekly drought measures of extreme and exceptional drought percentages and were averaged into a monthly account.

Since corn is a major input to the production of feeder cattle, the average prices of corn (dollars per bushel) received by farmers were used in the models. Other prices like U.S. feeder steers and U.S. fed steers were extracted from the LMIC. The prices for Mexican feeder steers from USDA Agricultural Marketing Service (USDA AMS) were also included in the calculations since Mexican cattle exports are depended on both U.S. and Mexican prices. Crude oil (petroleum) price (dollars per barrel) was used to capture some distance impacts. The longer the distance that trucks have to travel, the higher the oil, labor, and other associated risks cost. Other variables to discuss in the model were a linear and parabolic trend. Linear trend (X) and parabolic trend (X^2) measure the upward or downward movements, and lagged variable for number of cattle crossings captures dynamic changes based on the past values.

In addition, many of the variables that were used in this research were dummy variables representing the seasonal pattern in U.S. cattle imports from Mexico. In this study, the twelve monthly dummy variables were zero or one depending on the month of the year to consider the seasonal fluctuations; eleven dummy variables represent the 12 months of the year (December as a reference month).

Most importantly, the border violence was represented using dummy variables called Pdummy representing the closure of the Presidio port of entry and Tdummy representing opening of the temporary facility. The study defines the first indicator variable D =1 if port of entry was closed due to violence and D = 0 if port of entry was opened. For the temporary facility that was opened after 2 months of absolute closure, the study defines second indicator variable D = 1 for absolute port closure and D = 0 for the opening of the temporary facility. Descriptive statistics of the variables incorporated in the model are presented in Table 2.

The study attempts to measure the impact of a closed port of entry on the nearby ports of entry through the use of a regression in Stata software, a series of economic explanatory variables, and a dummy variable for port of entry openings and closure. One of the objectives is achieved using the OLS regression to test for statistical significance of cattle inflows between the Presidio port of entry and the Santa Teresa port of entry and if closure causes the diversion of the cattle imports from Mexico. The Presidio, Texas port of entry is across from Ojinaga, Chihuahua and is about 241 miles away from the Santa Teresa, NM port of entry. The Presidio port of entry was closed for 22 months from August 2012 to June 2014 due to repeated security concerns including local violence (Brezosky 2014). Given limited data, within the 22 months period of closure the temporary facility was opened for 20 months. This implies that the Presidio port of entry had 2 months of no inflows from August 2012 to September 2012.

However, the imported data from WiserTrade are determined by port of unlading, therefore the numbers for the two periods period of the absolute border closures were given values. In other words, for those two periods the cattle were first transported to the Presidio port of entry and were unloaded, however, they were imported from the other ports of entry (see Figure 5).

Looking at Figure 5, the two ports are moving together in 2009 and 2011. After May 2012, there was a decreasing trend of cattle inflows through two ports of entry and in August 2012 during the port closure, they faced the extremely low volumes of cattle inflows. There is a possibility that the decreasing trend that started from May 2012 was caused by the violence in the region. Then the inflow was stabilized in October 2012 when the temporary facilities were established.

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Then the other port equations will be modeled using the same explanatory variables except that one explanatory port (independent variable) becomes the explained port (dependent variable) for the next equation. For example, after Santa Teresa modeling, the explained variable SantaTeresa will become the explanatory variable for the other equations; Nogales will become the explained variable for its equations and will be the explanatory variable for the other equations.

Secondly, models are jointly estimated using the SUR estimator. The SUR model is a system of linear equations with error terms that are correlated across equations for a given port of entry. It is hypothesized that the geographical locations of the ports are conceptually related equations; therefore, this study recognizes that there is a potential for correlation between the error terms of the two equations. If the error terms are correlated, the SUR model is an appropriate technique for addressing cross-equation error correlation, and will gain efficiency by using the SUR model.

Results and Discussion

The OLS results of the estimated port of entry equations are reported in Table 3. It can be seen from the table that border closing at the Presidio port of entry had a statistically positive effect on exports through the Santa Teresa port of entry. Using a temporary facility opened at the Presidio port of entry does not make our results statistically significant. Other ports of entry that are within a 200~ 250 miles range from Santa Teresa, NM; also see larger crossings due to border closure, including Douglas (204.7 miles), Columbus (59.7 miles), and Presidio (241 miles). For instance, Columbus, Douglas, Presidio and Santa Teresa ports of entry exhibit a positive relationship, and other ports of entry that are outside of the range are not statistically significant. On the other hand, Del Rio (447 miles) and Santa Teresa ports of entry exhibit a negative relationship, or may be substitutes of each other.

From the OLS results, if the Presidio port of entry is closed due to violence, then an average of 16,212 more cattle per month cross the Santa Teresa port of entry. The

Santa Teresa port of entry is positively related to the ports that are within 200~ 250 miles range.

Using Stata software, the estimated parameters from the OLS output and the SUR output are compared. For OLS, the single equation regression models explained at least 76.90% (R^2) and 54.47% (adjusted R^2) of the variability in monthly cattle crossings at each port of entry in Table 4. In consideration of their significance using p-values, the signs of the prices for corn, U.S. feeder steers, U.S. fed steers, Mexican feeder steers, exchange rates, oils, droughts, and trends were mixed; the Laredo model had no statistically significant variables and the Hidalgo and San Luis model had very few statistically significant variables.

The OLS results to SUR results are compared in Table 6. For instance, using OLS and SUR Santa Teresa, New Mexico port of entry model is specified as:

$$POE_i = \alpha + \beta_1 POE_j + \beta_2 STlag + \beta_3 Plag + \beta_4 T + \beta_5 T^2 + \beta_6 S + \beta_7 Corn + \beta_8 Drought + \beta_9 USfeeder + \beta_{10} USfed + \beta_{11} exchrate + \beta_{12} MXfeeder + \beta_{13} Oil + \beta_{14} P + \beta_{15} Temp + \varepsilon$$

where POE = one of ten ports of entry
T = trend
S = monthly seasons
P = Presidio Dummy
Temp = Temporary Dummy

The SUR models explained at least 74.62% of the variability in monthly cattle crossings at each port of entry. According to Table 6, Pdummy was significant in Santa Teresa, Laredo, Douglas, Del Rio, Columbus, and Presidio; and Tdummy was significant in Santa Teresa, Del Rio, and Columbus.

Because the data has a relatively small number of observations being predicted with a relatively large number of variables, both R^2 and the adjusted R^2 are reported for

OLS equations. Only R^2 is reported for SUR because the SUR estimation procedure is optimal under the contemporaneous correlation assumption, so no standard error adjustment is necessary (Hill, Griffiths, and Lim 2011).

Overall, the R^2 values from OLS were greater than the R^2 values from SUR. However, when the adjusted R^2 values from OLS were compared with the R^2 values from SUR, higher R^2 values from SUR were observed.

With SUR, the study found smaller standard errors for all equations compared to OLS (see Table 6). The standard error of the regression is an estimator of the standard deviation of the error term; thus, SUR gives better estimates of the variable parameters than the OLS results, and it has increased the efficiency of the statistical results.

More differences in the number of statistically significant variables between the OLS and SUR techniques are observed in Table 6. OLS left out significant variables and this could be problematic if the model cannot capture important effects. Therefore, SUR is a better estimation.

Similar to the OLS results, SUR showed border closing at the Presidio port of entry had a statistically positive effect on exports through the Santa Teresa port of entry. Given the Presidio port closure, the Santa Teresa port of entry exhibited a positive relationship with Nogales, Laredo, Douglas, Columbus, and Presidio and a negative relationship with Eagle Pass, Del Rio, and San Luis. The OLS estimations had four port variables and the SUR estimations had eight port variables explaining the independent variable Santa Teresa. For different ports of entry, the same logical process can be used to determine each model.

Examining the Presidio port closure effects, the OLS and SUR estimations gave two different results (see Table 6). The OLS results reveal that two affected ports were Presidio and Santa Teresa. In contrast, the SUR results reveal that the impact of the Presidio port of entry closure was significant in all ports of entry except for San Luis, Nogales, Eagle Pass, and Hidalgo, which are the ports near the ends of the U.S. and Mexico border (see Figure 2 and Table 6). When the Presidio port of entry was closed, positively affected ports were Santa Teresa and Del Rio and negatively affected ports were Laredo, Douglas, Columbus, and Presidio. Thus more ports were negatively affected by the Presidio port closure; however, a significantly large number of cattle crossings through the Santa Teresa ports are observed compared to other ports.

The SUR estimation captured the port of entry closure and the temporary facility's significance. The Santa Teresa model implies that when the Presidio port of entry is closed, an average of 23,703 more cattle per month were imported through the Santa Teresa port of entry. However, when a temporary facility was opened in Presidio, an average of 15,472 fewer cattle per month were imported through the Santa Teresa port of entry, which is consistent with our a priori expectation.

The results show the significant effect of the temporary facility in the Presidio port. Similar results were shown for the Del Rio and Columbus ports of entry. After allowing correlations between the errors to occur, the SUR results indicated that the effect of the temporary facility in the Presidio port of entry that when the temporary facility was opened, the cattle crossings through the Santa Teresa port of entry was decreased by 1-(15,472/23,703) = 35%. This analysis suggests that the temporary facility in the Presidio port of entry played an important role, possibly mitigating the impact of port closures caused by violence.

However, there are also limitations to SUR estimations. Going back to the Santa Teresa port of entry model, the distance measure was harder to capture using SUR estimations. It was hard to make a clear distinction of range of miles to the extent that show how ports were related in terms of distance. Or the study suggests that in most cases the impact of border closure was strong enough—and all of ports are integrated with one other—that one port of entry positively and negatively impacts each other.

Furthermore, using SUR Pdummy was significant in the Santa Teresa, Laredo, Douglas, Del Rio, Columbus, and Presidio ports; Tdummy was significant in the Santa Teresa, Del Rio, and Columbus ports. From the OLS results, Pdummy was significant in the Santa Teresa and Presidio ports; however, Tdummy was significant in the Del Rio port at the $p\text{-value} < 0.05$.

Overall, the study attempts to measure how much impact a closed port of entry has on the nearby ports of entry. The OLS results show the importance of ports that are within 200~250 miles range from Santa Teresa that are both statistically significant and positively related. However, using SUR showed more and fewer cattle crossings were independent from distance. More attention given to the opening of the temporary facility in Presidio resulted in an opposite sign, which indicates that establishing the temporary facility offsets the effect of port closure. SUR increased efficiency in the estimated model parameters by correcting for error correlations and providing more statistically significant estimates of the variable than the OLS results. Also, the SUR estimations display smaller standard errors with higher R^2 compared to adjusted R^2 from the OLS estimations.

Therefore, SUR is a better estimation technique, although OLS provides minor advantages.

Conclusion

This study examined the impact of border closures on the movements of feeder cattle trade between the United States and Mexico. Given the ten major ports, the ten models presented captured the strong seasonal marketing patterns, and the figures and tables illustrate the distributions of U.S. imports of Mexican feeder cattle by port of entry. The research presented a comparison of the OLS and SUR estimations and showed the clear benefits of using SUR. When equations were estimated with OLS, the signs and magnitudes of coefficients were similar to those found with SUR. But smaller standard errors with higher R^2 (compared to adjusted R^2 from OLS) of the SUR regressions were found. Also, more statistically significant variables explained the port of entry models using SUR; therefore, this study concludes that the SUR regressions yield more precise estimates in most cases.

Based on the SUR estimation techniques, the volume of imports is not necessarily distance dependent. This study finds that the Presidio port closure from the SUR results affected more ports compared to the OLS results, and the temporary facility played a significant role in the flow of Mexican cattle into the United States.

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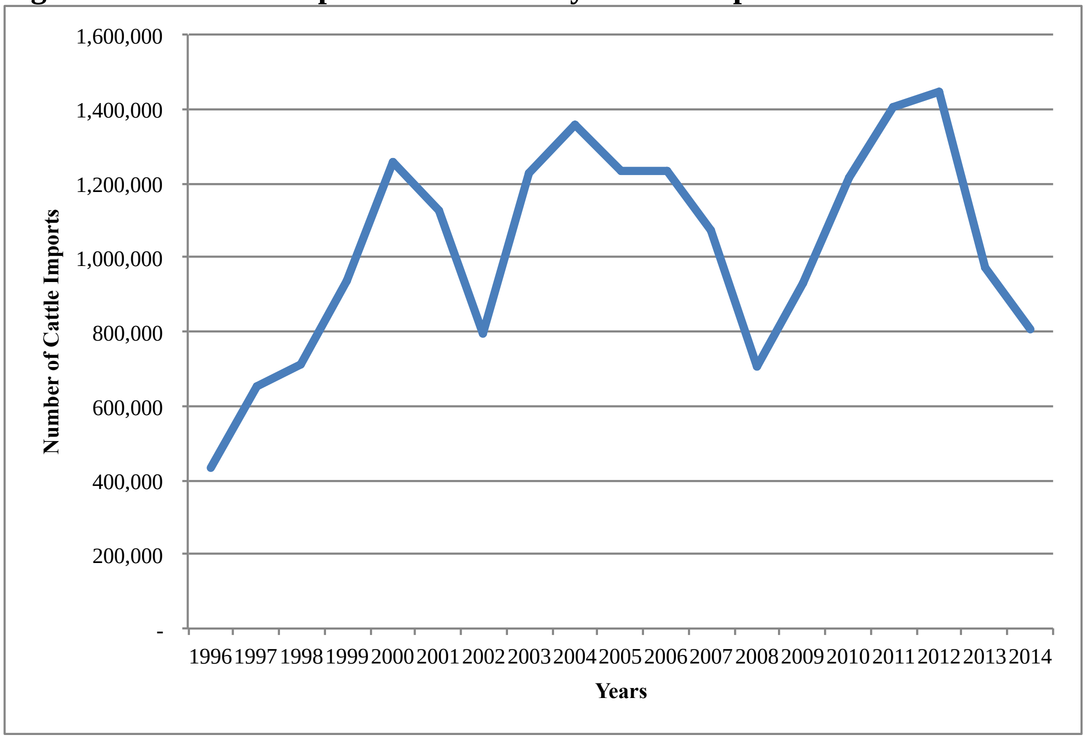
Figure 1. Total U.S. Imports from January 1996 to September 2014

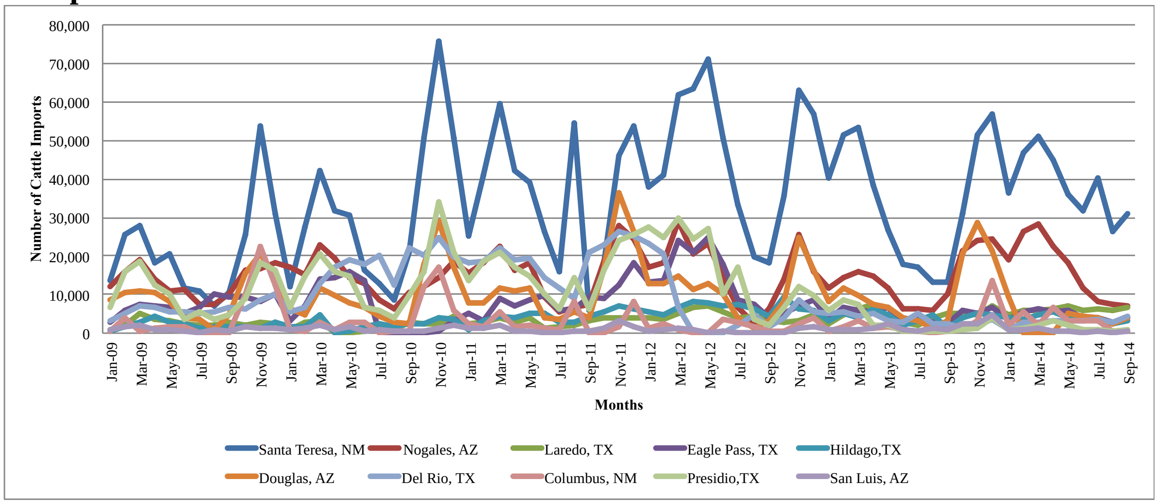


Source: USDA, Agricultural Markets Service 2014

Figure 2. Map of U.S.-Mexico Border Regions

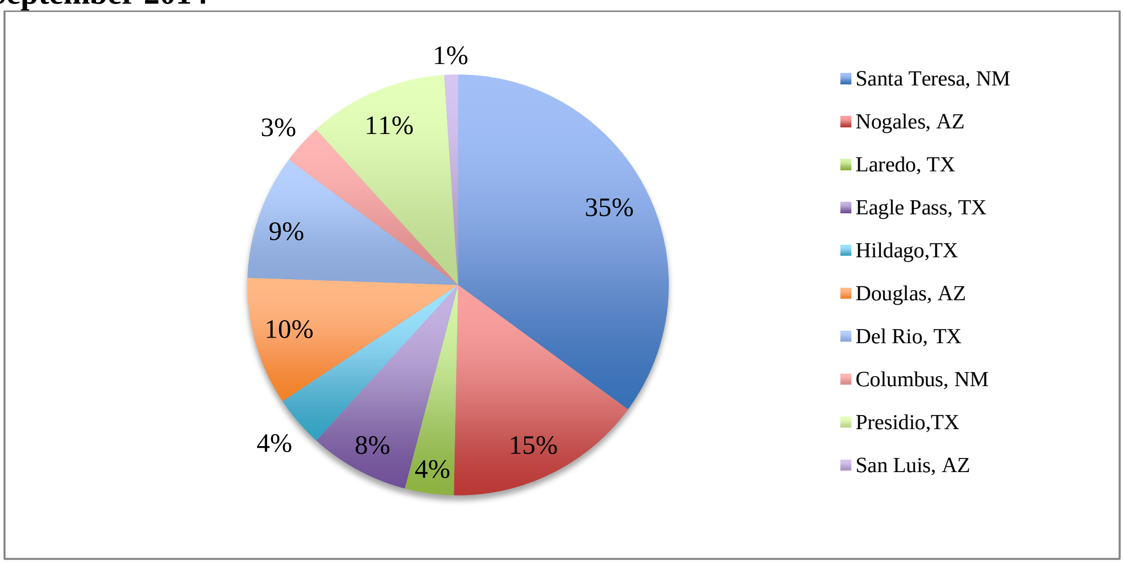
Source: USDA, ERS 2014

Figure 3. Monthly Cattle Imports from Mexico by Port of Entry from January 2009 to September 2014



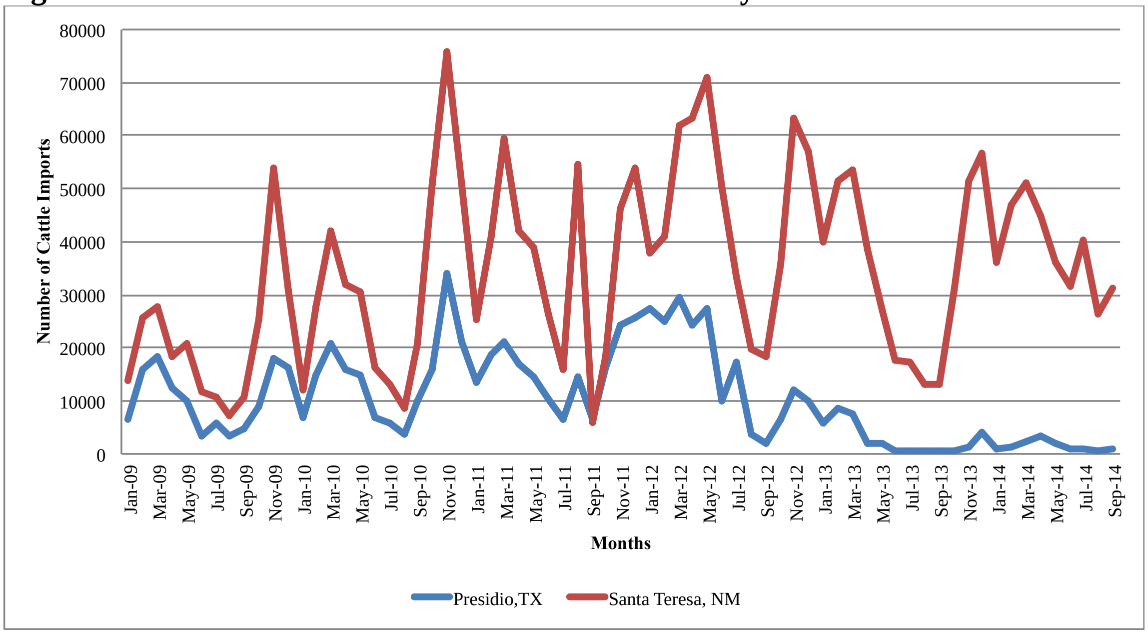
Source: WiserTrade 2015

Figure 4. U.S. Cattle Imports from Mexico by Port of Entry from January 2009 to September 2014



Source: WiserTrade 2015

Figure 5. The Presidio and Santa Teresa Ports of Entry



Source: WiserTrade 2015

Table 1. Percentage of Total Imports, January 1996 – September 2014

	DEL RIO TX	EAGLE PASS, TX	EL PASO TX	HIDALGO TX	LAREDO TX	PRESIDIO TX	COLUMBUS NM	SANTA TERESA NM	NOGALES AZ	DOUGLAS AZ	SAN LUIS AZ
1996	6	4	30	3	5	9	4		38	0	0
1997	6	4	31	2	6	20	4		23	3	2
1998	6	4	29	3	6	20	5		15	5	6
1999	8	4	29	4	5	19	5		12	7	7
2000	8	4	26	7	8	20	3		10	7	6
2001	11	4	22	8	10	20	4		10	5	6
2002	7	5	22	3	5	20	8		15	7	8
2003	9	4	22	8	5	21	6		13	8	3
2004	12	6	14	12	7	17	3	9	13	5	2
2005	11	9		10	6	13	3	28	13	6	1
2006	13	11		8	5	12	2	26	13	9	1
2007	11	10		9	4	14	3	27	13	7	1
2008	8	8		4	2	13	5	29	17	10	2
2009	8	9		4	4	13	5	30	15	10	1
2010	16	6		3	3	14	4	31	13	8	1
2011	17	7		5	4	14	3	27	13	9	1
2012	6	11		6	6	16	2	31	12	8	1
2013	5	7		6	8	4	4	37	16	11	2
2014	5	7		6	11	2	5	37	21	5	1

Source: USDA Market News Service, 2014

Table 2. An Overview of All Variables Included in this Analysis

Variable Name	Variable Definition
Santa Teresa	number of cattle imported from Santa Teresa port of entry
STlag	lagged number of cattle imported from Santa Teresa port of entry
Nogales	number of cattle imported from Nogales port of entry
Laredo	number of cattle imported from Laredo port of entry
EaglePass	number of cattle imported from Eagle Pass port of entry
Hildago	number of cattle imported from Hildago port of entry
Douglas	number of cattle imported from Douglas port of entry
DelRio	number of cattle imported from Del Rio port of entry
Columbus	number of cattle imported from Columbus port of entry
Presidio	number of cattle imported from Presidio port of entry
Plag	lagged number of cattle imported from Presidio port of entry
SanLuis	number of cattle imported from San Luis port of entry
Pdummy	monthly dummy variable for Presidio port of entry (0=open, 1 = closure)
Ldummy	monthly dummy variable for Laredo port of entry (0=open, 1 = closure)
Hdummy	monthly dummy variable for Hildago port of entry (0=open, 1 = closure)
Tdummy	monthly dummy variable for Presidio port of entry with temporary facility opened
Drought	cumulative drought severity in south region
Corn	average price of corn received by farmers
Usfeeder	U.S. feeder steer prices
Usfed	U.S. fed cattle prices
Mxfeeder	Mexican feeder steer prices
Exchrate	average exchange rate, USD/MXN
Oil	average of three spots
Trend	linear variable
Trend2	seasonal variable
Jan	monthly dummy variable for the month of January
Feb	monthly dummy variable for the month of February
Mar	monthly dummy variable for the month of March
Apr	monthly dummy variable for the month of April
May	monthly dummy variable for the month of May
Jun	monthly dummy variable for the month of June
Jul	monthly dummy variable for the month of July
Aug	monthly dummy variable for the month of August
Sep	monthly dummy variable for the month of September
Oct	monthly dummy variable for the month of October
Nov	monthly dummy variable for the month of November
Dec	monthly dummy variable for the month of December
$b_{0....}b_k$	estimated parameters

Table 3. Results of OLS, Santa Teresa Port of Entry

Number of obs	68
F(33, 34)	16.09
Prob > F	0
R-squared	0.9398
Adj R-squared	0.8814
Root MSE	5942.2

SantaTeresa	Coef.	Std. Err.	t	P>t
STlag	-	-	-	-
Nogales	-	-	-	-
Laredo	-	-	-	-
EaglePass	-	-	-	-
Hidalgo	-	-	-	-
Douglas	0.9550405	0.3421264	2.79	0.009
DelRio	-0.7655267	0.2706927	-2.83	0.008
Columbus	1.417242	0.3555655	3.99	0
Presidio	1.037587	0.3327957	3.12	0.004
Plag	-	-	-	-
SanLuis	-	-	-	-
Pdummy	16212.26	6697.33	2.42	0.021
Tdummy	-	-	-	-
Corn	-	-	-	-
Drought	-	-	-	-
USfeeder	-	-	-	-
USfed	-	-	-	-
exchrate	-	-	-	-
MXfeeder	-	-	-	-
oil	-	-	-	-
Jan	-	-	-	-
Feb	-	-	-	-
Mar	-	-	-	-
Apr	-	-	-	-
May	-	-	-	-
Jun	-	-	-	-
Jul	-	-	-	-
Aug	-	-	-	-
Sep	-	-	-	-
Oct	-	-	-	-
Nov	-	-	-	-
Trend	-	-	-	-
Trend2	-22.87134	9.22856	-2.48	0.018
_cons	-	-	-	-

Table 4. Results of OLS

Equation	RMSE	R-sq	Adj R-sq	P
SantaTeresa	5942.2	0.9398	0.8814	0.0000
Nogales	2394.5	0.9314	0.8648	0.0000
Laredo	902.4	0.8791	0.7918	0.0000
EaglePass	2999.0	0.8393	0.6834	0.0000
Hidalgo	1143.9	0.8333	0.6714	0.0000
Douglas	2686.7	0.9381	0.8781	0.0000
DelRio	3387.3	0.9047	0.8122	0.0000
Columbus	2366.1	0.8416	0.6880	0.0000
Presidio	2700.4	0.9514	0.9042	0.0000
SanLuis	541.7	0.7690	0.5447	0.0003

Table 5. Results of SUR

Equation	RMSE	R-sq	Chi2	P
SantaTeresa	4888.9	0.9185	1224.4	0.0000
Nogales	1805.3	0.9220	956.9	0.0000
Laredo	673.5	0.8653	535.6	0.0000
EaglePass	2327.4	0.8065	424.3	0.0000
Hidalgo	872.9	0.8058	391.0	0.0000
Douglas	2165.1	0.9196	1133.6	0.0000
DelRio	2687.5	0.8800	749.6	0.0000
Columbus	1838.4	0.8088	445.4	0.0000
Presidio	2095.0	0.9415	1411.1	0.0000
SanLuis	401.5	0.7462	262.8	0.0000

Table 6. Results of OLS and SUR

	OLS	SUR	OLS	SUR	OLS	SUR	OLS	SUR	OLS	SUR
	SantaTeresa	SantaTeresa	Nogales	Nogales	Laredo	Laredo	EaglePass	EaglePass	Hidalgo	Hidalgo
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
SantaTeresa	-	-	-	0.224***	-	0.048**	-	-0.176**	-	-
	-	-	-	-0.04	-	-0.02	-	-0.06	-	-
STlag	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
Nogales	-	1.379***	-	-	-	-	-	0.430**	-	0.158**
	-	-0.27	-	-	-	-	-	-0.15	-	-0.06
Laredo	-	2.097**	-	-	-	-	-	-1.625***	-	0.654***
	-	-0.74	-	-	-	-	-	-0.36	-	-0.14
EaglePass	-	-0.690**	-	0.274**	-	-0.147***	-	-	-	-
	-	-0.23	-	-0.09	-	-0.03	-	-	-	-
Hidalgo	-	-	-	0.692**	-	0.407***	-	-	-	-
	-	-	-	-0.24	-	-0.09	-	-	-	-
Douglas	0.955**	1.492***	-	-0.257*	-	-	-	0.494***	-	-0.113*
	-0.34	-0.22	-	-0.11	-	-	-	-0.13	-	-0.05
DelRio	-0.766**	-1.211***	-	0.241**	-	-	-0.431**	-0.651***	-	-0.079*
	-0.27	-0.17	-	-0.08	-	-	-0.13	-0.08	-	-0.04
Columbus	1.417***	1.819***	-	-0.355**	-	-	-	0.483**	-	-0.177**
	-0.36	-0.21	-	-0.12	-	-	-	-0.15	-	-0.05
Presidio	1.038**	1.358***	-	-0.396***	-	-0.110**	-	0.278*	-	0.244***
	-0.33	-0.21	-	-0.1	-	-0.04	-	-0.13	-	-0.05
Plag	-	-	-	-	-	0.067*	-	-	-	-0.094*
	-	-	-	-	-	-0.03	-	-	-	-0.04
SanLuis	-	-3.980**	-	-	-	-	-	-	-	-
	-	-1.27	-	-	-	-	-	-	-	-
Pdummy	16212.263*	23703.226***	-	-	-	-1805.553*	-	-	-	-
	-6697.33	-4630.39	-	-	-	-741	-	-	-	-
Tdummy	-	-15472.089**	-	-	-	-	-	-	-	-
	-	-5424.91	-	-	-	-	-	-	-	-
Corn	-	-	-2805.836**	-2240.072***	-	-	-	-1643.612*	-	794.248**
	-	-	-782.8	-550.13	-	-	-	-774.33	-	-292.41
Drought	-	-	-	-	-	15.888*	-	50.855*	-	-
	-	-	-	-	-	-7.01	-	-23.04	-	-
USfeeder	-	-	-	-195.735*	-	-	-	211.202*	125.100*	133.423***
	-	-	-	-85.51	-	-	-	-107.73	-55.38	-38.88
USfed	-	1138.397***	-	-	-	-134.406**	-	-	-	120.790*
	-	-292.17	-	-	-	-45.58	-	-	-	-59.71
exchrate	-	-8442.771**	4193.707**	4245.240***	-	1129.014**	-	-	-	-1854.009***
	-	-2649.2	-1451.1	-1016.69	-	-417.76	-	-	-	-531.11
MXfeeder	-	-	-	-	-	-	-	-	-	-110.320***
	-	-	-	-	-	-	-	-	-	-33.15
oil	-	-485.487**	269.478**	283.223***	-	-	-	-	-	-92.671**
	-	-159.5	-82.83	-58.41	-	-	-	-	-	-30.88
Jan	-	8935.731*	-	-	-	-	-	-	-	-2405.792**
	-	-4389.98	-	-	-	-	-	-	-	-831.6
Feb	-	11317.751*	-	-	-	-	-	-	-3014.264*	-3686.145***
	-	-4909.31	-	-	-	-	-	-	-1322.15	-925.66
Mar	-	-	-	-	-	2112.306**	-	6905.079**	-3130.237*	-4571.273***
	-	-	-	-	-	-748.75	-	-2469.32	-1282.2	-893.84
Apr	-	9559.456*	-	-	-	1664.889*	-	6426.168**	-	-3414.841***
	-	-4593.35	-	-	-	-729.7	-	-2369.73	-	-886.7
May	-	15839.098***	-	-3864.677*	-	1717.393*	7315.827*	9703.412***	-	-2890.236**
	-	-4637.34	-	-1967.19	-	-741.35	-3328.4	-2328.16	-	-909.21
Jun	-	30550.801***	-8089.624*	-10371.526***	-	-	-	9559.294**	-	-
	-	-5700.95	-3247.95	-2279.43	-	-	-	-3028.27	-	-
Jul	-	31029.297***	-10911.510**	-12394.476***	-	-	-	9122.767**	-	-
	-	-6588.2	-3556.72	-2501.29	-	-	-	-3492.13	-	-
Aug	-	32656.389***	-13204.715***	-14757.887***	-	-	-	10586.440**	-	-
	-	-6661.53	-3403.41	-2394.42	-	-	-	-3536.21	-	-
Sep	-	26271.796***	-11894.095**	-13090.338***	-	-	-	11773.049***	-	-
	-	-6599.55	-3404.63	-2394.83	-	-	-	-3416.66	-	-
Oct	-	-	-	-4711.196*	-	-	-	-	-	-
	-	-	-	-1886.87	-	-	-	-	-	-
Nov	-	-11438.900**	-	-	-	-	-	-5876.703**	-	1643.794*
	-	-4048.9	-	-	-	-	-	-2046.83	-	-794.16
Trend	-	-	-	-	-	-	-	640.496**	-	-
	-	-	-	-	-	-	-	-228.07	-	-
Trend2	-22.871*	-29.773***	-	-	-	-	-12.043*	-13.959***	-	-
	-9.23	-6.38	-	-	-	-	-4.62	-3.19	-	-
_cons	-	-	-	-	-	-	-55173.398*	-43134.017*	-	-
	-	-	-	-	-	-	-26924.35	-18934.26	-	-

* p < 0.05, ** p < 0.01, *** p < 0.001

Standard errors are given below coffeicients in parenthesis.

Table 6. Continued

	OLS	SUR	OLS	SUR	OLS	SUR	OLS	SUR	OLS	SUR
	Douglas	Douglas	DelRio	DelRio	Columbus	Columbus	Presidio	Presidio	SanLuis	SanLuis
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
SantaTeresa	0.195**	0.305***	-0.249**	-0.393***	0.225***	0.288***	0.214**	0.280***	-	-0.033**
	-0.07	-0.04	-0.09	-0.06	-0.06	-0.03	-0.07	-0.04	-	-0.01
STlag	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
Nogales	-	-0.323*	-	0.482**	-	-0.347**	-	-0.504***	-	-
	-	-0.13	-	-0.17	-	-0.11	-	-0.13	-	-
Laredo	-	-	-	-	-	-	-	-0.985**	-	-
	-	-	-	-	-	-	-	-0.34	-	-
EaglePass	-	0.397***	-0.550**	-0.831***	-	0.301**	-	0.226*	-	-
	-	-0.1	-0.17	-0.11	-	-0.09	-	-0.11	-	-
Hidalgo	-	-0.622*	-	-0.691*	-	-0.759**	-	1.361***	-	-
	-	-0.27	-	-0.35	-	-0.23	-	-0.26	-	-
Douglas	-	-	-	0.588***	-0.380**	-0.654***	-	-	0.089**	0.137***
	-	-	-	-0.14	-0.14	-0.09	-	-	-0.03	-0.02
DelRio	-	0.370***	-	-	-	0.274***	0.363**	0.531***	-	-
	-	-0.09	-	-	-	-0.08	-0.12	-0.08	-	-
Columbus	-0.490**	-0.844***	-	0.562***	-	-	-	-	-	0.076**
	-0.18	-0.11	-	-0.16	-	-	-	-	-	-0.03
Presidio	-	-	0.571**	0.836***	-	-	-	-	-	-
	-	-	-0.19	-0.12	-	-	-	-	-	-
Plag	-	-	-	-	-	-	-	0.218*	-	-
	-	-	-	-	-	-	-	-0.1	-	-
SanLuis	2.194**	3.363***	-	-	-	1.456**	-	-	-	-
	-0.76	-0.49	-	-	-	-0.52	-	-	-	-
Pdummy	-	-4900.395*	-	11015.278***	-	-5425.731**	-9949.483**	-10189.525***	-	-
	-	-2220.98	-	-2745.07	-	-1911.79	-2819.25	-1981.17	-	-
Tdummy	-	-	-9805.377*	-9607.347**	-	4371.037*	-	-	-	-
	-	-	-4269.43	-3011.19	-	-2199.76	-	-	-	-
Corn	-	-	-2614.082*	-1939.734*	-	-	-	-	-	-
	-	-	-1220.12	-854.44	-	-	-	-	-	-
Drought	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
USfeeder	-	-	-	297.549*	-	-	-	-312.022***	-	-43.773*
	-	-	-	-120.07	-	-	-	-94.61	-	-19.38
USfed	-	-	723.036**	627.343***	-	-	-428.243*	-517.080***	-	-
	-	-	-222.53	-154.56	-	-	-189.34	-131.32	-	-
exchrate	-	-	-	-	-	-	5263.334**	5902.563***	-	-
	-	-	-	-	-	-	-1587.83	-1116.61	-	-
MXfeeder	-	-164.743*	-	-	-233.659*	-216.056**	-	224.101**	-	-
	-	-79.49	-	-	-94.49	-66.22	-	-78.38	-	-
oil	-	-	-	-193.215*	-	-	-	264.620***	-	-
	-	-	-	-91.89	-	-	-	-71.61	-	-
Jan	-6825.484*	-5726.433**	-	-	-6541.849**	-6945.355***	-	-	-	-
	-2702.63	-1859.68	-	-	-2338.64	-1622.13	-	-	-	-
Feb	-10439.207***	-9887.562***	-	-	-7600.789**	-9366.635***	-	-	-	-
	-2812.88	-1948.71	-	-	-2631.28	-1818.04	-	-	-	-
Mar	-10814.118***	-11304.616***	-	-	-8138.029**	-9887.904***	-	6422.236**	-	1038.754*
	-2686.93	-1864.18	-	-	-2513.85	-1727.15	-	-2179.18	-	-448.66
Apr	-9454.799**	-9152.346***	-	-	-7787.519**	-8942.235***	-	-	-	-
	-2678.5	-1842.39	-	-	-2412.48	-1662.81	-	-	-	-
May	-10147.043***	-10529.765***	-	7009.707*	-8333.679**	-10225.332***	-	-	-	-
	-2669.4	-1831.82	-	-2755.68	-2415.13	-1671.49	-	-	-	-
Jun	-10643.126**	-9878.168***	-	13030.459***	-7414.198*	-9829.252***	-9048.592*	-10162.502***	-	-
	-3517.4	-2428.26	-	-3398.09	-3250.11	-2260.65	-3668.32	-2573.41	-	-
Jul	-11693.809**	-11025.872***	-	11093.344**	-9043.785*	-11541.624***	-	-8256.848**	-	-
	-4038.86	-2794.92	-	-3939.14	-3655.93	-2549.09	-	-3065.62	-	-
Aug	-12264.244**	-11505.512***	-	12510.379**	-7812.301*	-11158.831***	-	-9764.724**	-	-
	-4076.12	-2829.02	-	-3993.4	-3810.86	-2644.85	-	-3074.45	-	-
Sep	-10382.900*	-9709.347***	-	12052.565**	-	-10134.095***	-	-8044.402**	-	-
	-4081.71	-2823.57	-	-3879.92	-	-2592.18	-	-3021.44	-	-
Oct	-	-	-	-	-	-	-	-4313.010*	-1505.418*	-1373.077***
	-	-	-	-	-	-	-	-2178.62	-583.95	-411.79
Nov	8966.401***	9846.724***	-	-5261.340*	-	5951.691***	-	-	-1232.581*	-1533.913***
	-2208	-1550.4	-	-2341.08	-	-1589.49	-	-	-499.6	-346.09
Trend	-	-418.295*	-	653.468*	-	-	-	-	-	-
	-	-213.36	-	-257.28	-	-	-	-	-	-
Trend2	-	9.795**	-	-20.328***	8.185*	9.242***	-	8.844**	-	-
	-	-3.06	-	-3.38	-3.74	-2.6	-	-3.07	-	-
_cons	-	-	-	-	-	30745.933*	-	-	-	-
	-	-	-	-	-	-15248.12	-	-	-	-

* p < 0.05, ** p < 0.01, *** p < 0.001

Standard errors are given below coffeicients in parenthesis.