Cross-Border Cargo Traffic Through a Rural Texas Port of Entry

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Most econometric analyses of cross-border traffic flows from Mexico have been conducted for the larger metropolitan economies along the international boundary. With the advent of the USMCA trade agreement, plus physical infrastructure bottlenecks at many ports of entry, ports of entry in smaller cities and towns are likely to play more important roles in expediting cross-border merchandise trade. To date, however, there has been very little formal analyses of the trade flows through many of these other, potentially key ports. This study attempts to partially fill part of that gap in the border economics literature by analyzing northbound cargo vehicle flows from Mexico to the United States through Ojinaga, Chihuahua and Presidio, Texas. Results indicate that the price of diesel fuel, United States business cycles, export manufacturing employment in Chihuahua City, and the inflation adjusted bilateral currency value of the peso influence the monthly volume of cargo trucks that use this border crossing facility.

Keywords: international trade, Presidio-Ojinaga, border economics

INTRODUCTION

Presidio, Texas and Ojinaga Chihuahua are located next to each other on the international boundary between the United States and Mexico. Although small in size, this location plays a fairly prominent role in the transportation of merchandise that is traded between the two countries. In spite of that, very few studies have examined the cargo vehicle flows across the international bridge that connects these two small cities. The advent of the United States-Mexico-Canada Agreement in July 2020 means that this border crossing will likely convey even larger volumes of freight in the not too distant future.

This study examines northbound cargo vehicle flows that cross the border from Ojinaga to Presidio. Monthly data from January 2001 through December 2019 are analyzed using a time series econometric methodology that has been employed to quantify cargo vehicle flows through other ports of entry along the border. Subsequent sections of the study are as follows. A short literature review is provided next. Data and methodology are discussed in the third section. Empirical results are presented in the fourth section. The conclusion summarizes principle outcomes and offers suggestions for subsequent future research.

PRIOR STUDIES

There have been several studies that analyze cargo traffic flows from Mexico into the United States. Several of those efforts try to identify which variables cause fluctuations in monthly truck volumes. An early example is Fullerton and Tinajero (2002). Results in that study indicate that freight vehicle traffic across two separate international bridges into El Paso, Texas is reliably impacted by business cycle and currency market fluctuations. Two subsequent efforts employ the same methodology, but add the tolls charged on trucks as explanatory variables (De Leon et al., 2009; Fullerton et al., 2013). Results in both of the latter articles confirm that cross-border cargo toll reactions are very inelastic.

Xue et al. (2013) analyzes cargo vehicle that enter into the United States via the Mariposa port of entry in Nogales, Arizona. Results obtained for Nogales are similar to those reported for El Paso in Fullerton and Tinajero (2002). Again, the inclusion of business cycle and currency market variables is found to help explain fluctuations in northbound trucks that cross the border in Nogales. As anticipated by Phillips and Cañas (2008), lag structures and coefficient magnitudes in the Nogales equations differ from those obtained for El Paso. That outcome underscores the importance of modeling cross-border traffic flows for each individual port.

Approval of the United States – Mexico – Canada (USMCA) trade agreement probably insures that cross-border freight volumes will expand more rapidly than incomes and infrastructure capacity (Zhao et al., 2020). If merchandise trade shipments do grow faster than port-of-entry capacities in El Paso, many of the cargo exports that originate in Chihuahua City and other nearby cities are likely to be routed through Ojinaga and Presidio. Because of that, more in-depth knowledge of freight shipment patterns at that port would be helpful. The next section discusses the data and methodology employed to achieve that objective.

DATA AND METHODOLOGY

As listed in Table 1, three categories of northbound cargo vehicles are included in the sample as dependent variables: northbound cargo trucks (TRK), empty container trucks (TCE), and loaded container trucks (TCL). While several studies analyze total northbound truck volumes, this effort also models the flows of empty container and loaded container cargo vehicles. Not surprisingly, the latter are inversely correlated with each other. However, the correlation coefficient is only -0.28, indicating that the two series do not follow a very synchronous pattern and may react very differently to economic stimuli. Although companies prefer to move loaded trailers, "deadhead miles" tend to increase whenever there are supply chain disruptions that intensify coordination difficulties (Hariga et al., 2016).

Tolls are charged to cross some international bridges that link cities in Mexico with ports of entry in Texas. Tolls are not assessed on the Presidio-Ojinaga Bridge. That raises the question of how to measure the price for using that infrastructure (Fullerton and Solis, 2020). A viable approach is provided by resource economics where ground water tariffs are not charged and the effective price becomes the electricity rate associated with extracting the water (Gardner and Young, 1984). A candidate for a corresponding price measure in the case of any un-tolled bridge will be the price of fuel. For cargo trucks, the appropriate fuel price is that for diesel (USDSL).

Most of the trucks crossing the border are transporting maquiladora intermediate inputs that are at various stages of production. Maquiladora manufacturing output is primarily driven by the United States business cycle (Cañas et al., 2007). To capture variations in north of the border macroeconomic conditions, the United States Industrial Production Index is utilized (USIP).

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TABLE 1
VARIABLE NAMES AND DESCRIPTIONS

Variable	Description	Units	Sources
TRK	Northbound Cargo Trucks	Trucks	BTS
TCE	Truck Containers Empty	Containers	BTS
TCL	Truck Containers Loaded	Containers	BTS
USDSL	Real Price of U.S. Diesel, 1982-84 = 100	Dollars per Gallon	EIA
USIP	U.S. Industrial Production, 2017 = 100	Index, NSA	FRED
IMMEX	IMMEX Employment, Chihuahua	Workers	INEGI
MXREX	Real Exchange Rate, June 1997 = 100	Pesos per Dollar	BRMP

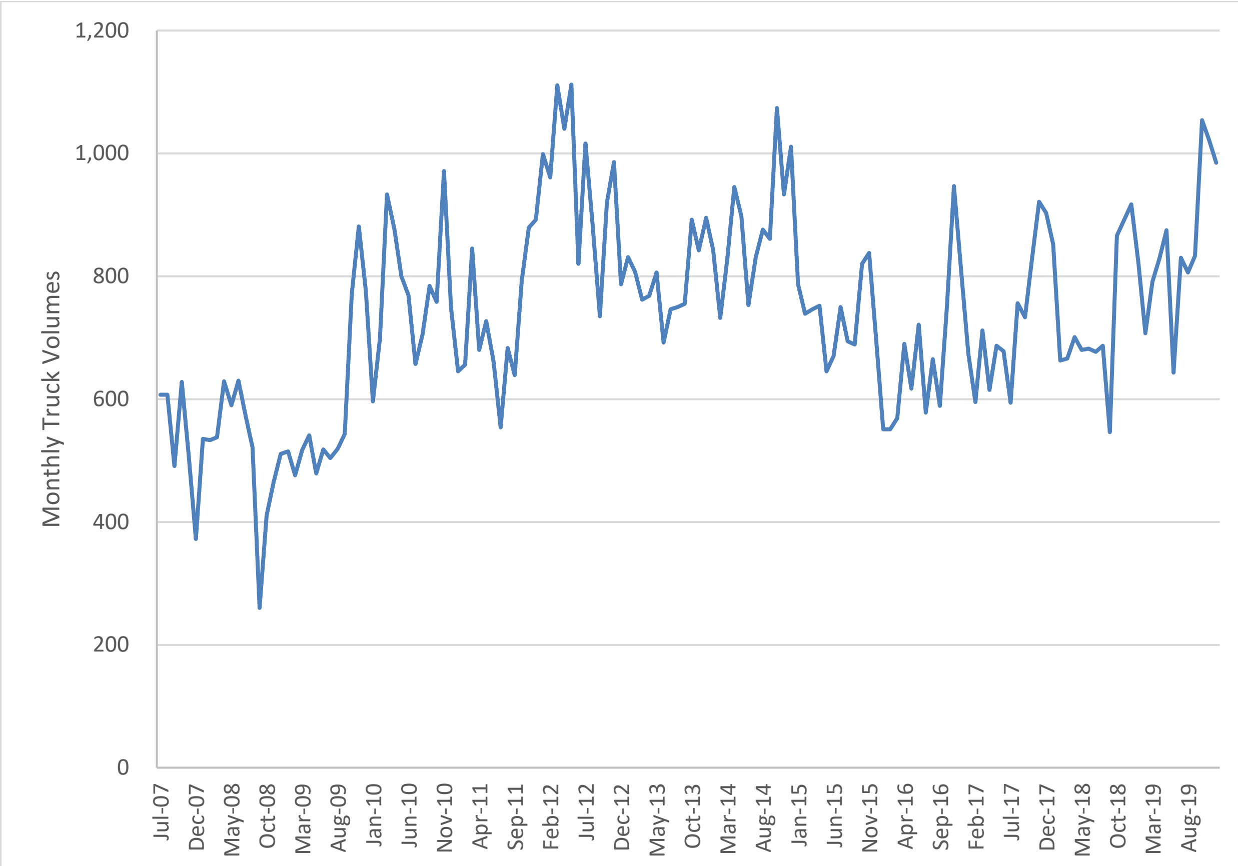
Notes:
Sample Period: July 2007 – December 2019
INEGI: Insitituto Nacional de Estadística y Geografía (Mexico)
FRED: Federal Reserve Bank of St. Louis Economic Data
BRMP: University of Texas at El Paso Border Region Modeling Project
BTS: United States Bureau of Transportation Statistics
EIA: United States Energy Information Administration
IMMEX: Export Manufacturing, Services, and Maquiladora Employment in Chihuahua City
NSA: Not Seasonally Adjusted

Regional maquiladora activities across Mexico exhibit individual business cycle patterns (Phillips and Cañas, 2008). The majority of the cargo vehicles that cross the international boundary in Presidio carry loads that originate in Chihuahua City. Given that, international manufacturing and maquiladora employment (IMMEX) in that metropolitan economy is also included as a potential explanatory variable. Also included in the sample is a real exchange rate index (MXREX) that has previously been found to help model cargo truck fluctuations at other ports of entry (Fullerton et al., 2013).

Summary statistics for the sample data are reported in Table 2. During the July 2007 – December 2019 sample period, an average of 737 trucks (TRK) per month crossed the bridge from Ojinaga to Presidio. For this sample, the peak volume of 1,112 occurred in May 2012, while the minimum of only 260 trucks was tallied in September 2009. The empty trucks (TCE) monthly average is 352 and the loaded trucks (TCL) is 375. Of the latter, TCL exhibits more variability and has a coefficient of variation of 43.6 percent. Although the coefficient of variation for TRK is fairly low, this series still exhibits a notable amount of variability in Figure 1.

The real price of diesel, USDSL, reached its sample maximum of $2.14 in June and July 2008. The $0.84 nadir for USDSL occurred in February 2016. The real diesel price data are platykurtic with a kurtosis of 2.067. Industrial activity, USIP, peaked in August 2018. The trough for this variable was notched in April 2009 during the banking crisis economic downturn. Chihuahua City maquiladora employment, IMMEX, achieved its zenith in May 2019. The low-water mark for this variable took place in June 2009.

FIGURE 1
NORTHBOUND CARGO TRUCKS - PRESIDIO INTERNATIONAL BRIDGE



Source: UTEP Border Region Modeling Project using data from the U.S. Bureau of Transportation Statistics.

For the real exchange rate index, MXREX, numbers above 100 indicate that the peso is undervalued against the dollar. If MXREX falls below 100, it implies that the peso is overvalued. During the sample period employed for this study, the most severe instance of peso undervaluation occurred in January 2017 when there was substantial uncertainty over the fate of North American trade relations. The peso reached its high-water mark against the dollar in August 2008, just prior to the United States financial market collapse.

Parameter estimation is carried out using a linear transfer function (LTF) methodology that has proven useful for modeling personal vehicle (Fullerton and Solis, 2020) and cargo vehicle traffic flows (Fullerton et al., 2013) at other border ports of entry. LTF models are useful in border modeling contexts because of the flexibilities provided with respect to accommodating different lag structures and data generating processes (Diebold, 2007). Lag structure candidates are identified via cross correlation functions estimated for stationary components of each truck variable with those of each of the explanatory variables (Trivez and Mur, 1999). LTFs are estimated for each of the cargo vehicle time series (TRK, TCE, TCL).

TABLE 2
SUMMARY STATISTICS

Variable Name	TRK	TCE	TCL	USDSL	USIP
Mean	736.6	351.5	375.1	$1.39	98.1
Median	742.5	370.0	337.0	$1.33	99.4
Std. Dev.	158.5	117.1	163.6	$0.296	4.9
Maximum	1,112.0	605.0	891.0	$2.14	106.2
Minimum	260.0	96.0	93.0	$0.84	84.1
Skewness	-0.011	-0.408	0.975	0.252	-1.013
Kurtosis	2.855	2.517	3.708	2.067	3.350
CV	0.215	0.333	0.436	0.212	0.050

Variable Name	IMMEX	MXREX
Mean	60,798	105.305
Median	65,479	103.030
Std. Dev.	12,894	12.703
Maximum	77,945	140.377
Minimum	34,593	85.206
Skewness	-0.540	0.501
Kurtosis	1.894	2.215
CV	0.212	0.121

Notes:
Sample Period: July 2007 – December 2019
Std. Dev. – Standard Deviation
CV – Coefficient of Variation

Equation (1) shows the implicit function form used for each of the three equations estimated. Hypothesized relationships between the cargo vehicle crossing volumes and each independent variable are shown in parentheses. In Equation (1), the subscript t is for monthly time period and subscripts i, j, k, and m are for the numbers of lags. Lag lengths are allowed to vary for each of the regressors.

$$TRK_t \;=\; f(\underset{(-)}{USDSL_{t-i}},\ \underset{(+)}{USIP_{t-j}},\ \underset{(+)}{IMMEX_{t-k}},\ \underset{(+)}{MXREX_{t-m}}) \qquad (1)$$

EMPRICAL RESULTS

Estimation results for the total number of trucks crossing the border through Presidio are summarized in Table 3. The real price of diesel enters the equation with a 3-period lag. Business cycle fluctuations exercise a strong effect on truck traffic across the Presidio International Bridge. Similar to what has been documented for IMMEX employment (Coronado et al., 2004), increases in north of the border industrial activity are followed by upticks in freight shipments through Presidio within 60 days. Chihuahua City IMMEX payrolls also affect northbound cargo flows through this POE within two months. As documented for one of the tolled bridges in El Paso (Fullerton et al., 2013), peso depreciation against the dollar precedes increases in northbound truck movements by 180 days.

TABLE 3
ALL CARGO TRUCKS (TRKS)

Variable	Coefficient	Std. Error	t-statistic	Probability
Constant	-0.2946	7.1066	-0.0415	0.9670
D(USDSL(-3))	-208.2799	107.0491	-1.9456	0.0537
D(USIP(-2))	29.1459	6.4703	4.5046	0.0000
D(IMMEX(-2))	0.0098	0.0039	2.5117	0.0132
D(MXREX(-6))	4.0446	2.2359	1.8090	0.0726
AR(1)	-0.2480	0.0806	-3.0782	0.0025
AR(15)	-0.2373	0.0856	-2.7710	0.0064
MA(12)	0.3837	0.0861	4.4548	0.0000
R-Squared	0.3558	Mean Dependent Variable		3.3605
Adjusted R-Sq.	0.3233	Std. Dev. Dep. Variable		112.2373
Pseudo R-Sq.	0.8310	Akaike Info. Criterion		11.9612
Std. Error Reg.	92.3253	Sum Sq. Residuals		1184830
Log-Likelihood	-871.1486	F-statistic		10.9668
Durbin-Watson	2.0778	Prob.(F-statistic)		0.0000
Inverted AR Roots	.87-.19i	.87+.19i	.72+.53i	.72-.53i
	.44+.79i	.44-.79i	.08-.90i	.08+.90i
	-.30-.86i	-.30+.86i	-.63-.67i	-.63+.67i
	-.85-.37i	-.85+.37i	-.93	
Inverted MA Roots	.89-.24i	.89+.24i	.65-.65i	.65+.65i
	.24+.89i	.24-.89i	-.24+.89i	-.24-.89i
	-.65+.65i	-.65+.65i	-.89-.24i	-.89+.24i

Notes:
Sample Period: October 2007 – December 2019
Number of Observations: 147
D is a first difference operator
AR(p) – stands for autoregressive coefficient at lag p.
MA(q) – stands for moving average coefficient at lag q.

A combination of two autoregressive and one moving average terms are required in order to procure white noise behavior in the residuals. Overall diagnostics reported in Table 3 are encouraging. More than 80 percent of the variation in the dependent variable in levels is accounted for by the equation. The computed t-statistics for the regressors have p-values of 0.073 or lower while that for the F-statistic is below 0.001.

Table 4 reports the estimation outcomes for empty trucks crossing the border via the Presidio POE. Linkages between this series and the explanatory variables are not as statistically reliable as those reported in Table 3. That is particularly the case for north-of-the-border industrial activity and the real currency value of the peso. That is probably because companies prefer to not send empty containers and do so only when motivated by necessities such as terminal space shortages or hauling capacity constraints. When those factors become binding, containers will be shipped before any loads can be contracted.

TABLE 4
TRUCK CONTAINERS EMPTY (TCE)

Variable	Coefficient	Std. Error	t-statistic	Probability
Constant	-1.6490	3.0289	-0.5444	0.5870
D(USDSL(-1))	-116.1343	61.3065	-1.8943	0.0603
D(USIP(-1))	0.7777	4.0805	0.1906	0.8491
D(IMMEX(-2))	0.0044	0.0027	1.6347	0.1044
D(MXREX(-6))	1.2032	1.4687	0.8192	0.4141
AR(1)	-0.3367	0.0836	-4.0298	0.0001
AR(12)	0.2464	0.0790	3.1193	0.0022
MA(2)	-0.3552	0.0876	-4.0552	0.0001
R-squared	0.2262	Mean Dependent Variable		-0.4014
Adjusted R-Sq.	0.1872	Std. Dev. Dep. Variable		68.1509
Pseudo R-Sq.	0.6783	Akaike Info. Criterion		11.1349
Std. Err. Reg.	61.4404	Sum Sq. Residuals		524714
Log-Likelihood	-810.4143	F-statistic		5.8048
Durbin-Watson	1.9459	Prob.(F-statistic)		0.0000
Inverted AR Roots	.87	.74+.44i	.75-44i	.42-.77i
	.42+.77i	-.03-.89i	-.03-.89i	-.47-.77i
	-.47+.77i	-.80+.44i	-.80-.44i	-.92
Inverted MA Roots	.60	-.60		

Notes:
Sample Period: October 2007 – December 2019
Number of Observations: 147
D is a first difference operator
AR(p) – stands for autoregressive coefficient at lag p.
MA(q) – stands for moving average coefficient at lag q.

Table 5 shows the estimation output for loaded containers. The diagnostic statistics for this data series are similar to those for all trucks. Approximately 86 percent of the changes in the dependent variable in levels is explained by the equation. Most of the computed t-statistic p-values indicate fairly dependable links between the regressors and subsequent movements in loaded container flows across the bridge to Presidio. As in Tables 3 and 4, there is a notable inertial component associated with the TCL. Four serial correction parameters are included in the specification with the longest being a moving average term at a 13-month lag.

Elasticity estimates are presented in Table 6. The price elasticities, as approximated by the elasticities of truck crossings with respect to the real price of diesel, range from -0.39 to -0.54. While inelastic, those results indicate a much higher degree of sensitivity to the cost of crossing than what is indicated by the toll elasticity reported for cargo vehicles in El Paso (Fullerton et al., 2013). That outcome is somewhat surprising because of the isolated nature of the Presidio International Bridge which has no alternative crossing routes within 200 miles. Because there are three ports of entry that can handle cargo traffic within 28 miles of each other in metropolitan El Paso, a higher price elasticity would logically be expected for ports in that region.

TABLE 5
TRUCK CONTAINERS LOADED (TCL)

Variable	Coefficient	Std. Error	t-statistic	Probability
Constant	1.2342	8.2755	0.1491	0.8817
D(USDSL(-3))	-146.4316	91.8096	-1.5949	0.1130
D(USIP(-2))	18.6530	5.2741	3.5367	0.0006
D(IMMEX(-2))	0.0065	0.0033	1.9925	0.0483
D(MXREX-5))	3.3303	1.9217	1.7330	0.0853
AR(1)	-0.2792	0.0806	-3.4622	0.0007
AR(12)	0.3036	0.0847	3.5858	0.0005
MA(10)	-0.1294	0.0809	-1.5985	0.1122
MA(13)	0.3751	0.0871	4.3050	0.0000
R-squared	0.3410	Mean Dependent Variable		3.7755
Adjusted R-Sq.	0.3028	Std. Dev. Dep. Variable		97.6810
Pseudo R-Sq.	0.8608	Akaike Info. Criterion		11.7182
Std. Error Reg.	92.3253	Sum Sq. Residuals		917983
Log-Likelihood	-852.2852	F-statistic		8.9274
Durbin-Watson	2.0604	Prob.(F-statistic)		0.0000
Inverted AR Roots	.88	.76+.45i	.76-.45i	.43-.78i
	.43+.78i	-.02+.90i	-.02-.90i	-.48-.78i
	-.48+.78i	-.81+.45i	-.81-.45i	-.93
Inverted MA Roots	.89+.20i	.89-.20i	.71+.61i	.71-.61i
	.33-.89i	.33+.89i	-.13-.91i	-.13+.91i
	-.51+.75i	-.51-.75i	-.82-.45i	-.82+.45i
	-.95			

Notes:
Sample Period: October 2007 – December 2019
Number of Observations: 147 D is a first difference operator
AR(p) – stands for autoregressive coefficient at lag p.
MA(q) – stands for moving average coefficient at lag q.

TABLE 6
CARGO TRUCK ELASTICITIES

Variable	USDSL	USIP	IMMEX	MXREX
TRKS	-0.3930	3.8816	0.8089	0.5782
TCE	-0.4593	0.2171	0.7611	0.3605
TCL	-0.5426	4.8783	1.0536	0.9349

The very low responsiveness of TCE to variations in USIP is not unexpected. Empty cargo container crossings result from factors other than business cycle fluctuations. The hyper-sensitivity of TRKS and TCL to changes in USIP is, however, rather startling. That degree of sensitivity is much higher than what is exhibited for truck flows into El Paso (Fullerton et al., 2013; Fullerton and Tinajero, 2002). Additional research using data from other non-metropolitan regions appears warranted.

The IMMEX elasticity for TCL in Table 6 is unitary. If maquiladora workers are on the payroll in Chihuahua City, a proportional number of loaded trucks are headed across the Presidio International Bridge every month. For the inflation adjusted, bilateral exchange rate index, MXREX, the elasticity is also found to be unitary. Real peso depreciations reduce the cost of manufacturing in Mexico and are found to be accompanied by proportional increases in the monthly volumes of trucks hauling merchandise into the United States through this port.

CONCLUSION

To date, there is relatively little information available regarding cargo vehicle flows via rural ports of entry from Mexico to the United States. This study examines the flows of total trucks, truck with empty containers, and trucks with loaded containers that traverse the Presidio International Bridge. The methodology employed is linear transfer function time series analysis, a method that has been previously applied to ports of entry in El Paso and Nogales. Because the Presidio Bridge is not tolled, the price of diesel fuel is used to approximate the price of using this infrastructure. That step emulates prior research conducted in the context of water economics.

Estimation results yielded several interesting outcomes. Employment of the real price of diesel seems to provide a useful means for approximating a price measure. As in research conducted for border metropolitan economies, the United States industrial production index functions well as a business cycle measure. Other useful regressors are export manufacturing employment in Chihuahua City and a real peso per dollar exchange rate index. Neither of the latter variables are determined in Presidio or Ojinaga, but influence the volumes of cargo headed to the United States through this region.

For this port of entry, the next logical step will be to examine whether personal vehicle traffic flows can be modelled using the same approach as employed in this effort. The price of using the bridge can potentially be approximated by the real price of regular unleaded gasoline. Because most of the ports of entry along the border with Mexico are not tolled, that same step may also prove useful for modelling small vehicle flows in other border regions, both rural and urban.

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