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## **CURRENCY MOVEMENTS AND INTERNATIONAL BORDER CROSSINGS\***

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### **ABSTRACT**

It is well known that merchandise trade flows respond to exchange rate policy changes over time. This topic, known in the economics literature as the J-curve effect, has been the subject of numerous studies. Exchange rate policies also impact commuter traffic between international metropolitan areas, but there has been much less attention devoted to understanding the effects of currency valuation shifts on border crossings between nations such as the United States and Mexico. While there has been some research conducted with respect to employment impacts on annual crossing volumes, the analysis has been limited to static models. The research at hand attempts to partially fill this gap in the existing literature by examining the response in international commuter flows to exchange rate valuation shifts. In order to gain better appreciation of the temporal aspects of border crossing reactions to policy changes of this nature, all of the analysis is conducted within a dynamic framework.

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## **INTRODUCTION**

Separated by the Rio Grande, El Paso and Ciudad Juarez together form one of the largest international metropolitan areas in the world. The two cities are the focal point on the border between the United States and Mexico. Four bridges, three of which carry northbound traffic, connect El Paso and Juarez: Paso del Norte (PDN) near downtown, the more centrally located Bridge of the Americas (BOTA) near Chamizal Park, and Ysleta-Zaragoza (ZARA) to the east of both cities. The bridges clearly provide the primary linkage on this international border. In 1987, more than 24.5 million people crossed the three structures to reach the Texas side of the river. To understand the dynamics of this unique regional economy requires careful consideration of traffic across the bridges. This paper considers one aspect of this problem by analyzing monthly northbound crossings to El Paso.

This topic represents a relatively unexplored area in the literature of economics and public administration. Most studies which analyze the interplay of cross-border economic flows and international exchange rates focus only on merchandise trade and physical good movements (for examples, see Bahmani-Oskoe, 1985, and Tegene, 1989). Other studies have gone farther in the direction of the study at hand, examining the impacts of devaluations on border employment patterns, especially in manufacturing (Harrel and Fischer, 1989). Cobb, Molina, and Sokulsky (1989) examine the effect of in-bond assembly plant (maquiladora) employment in Mexico on commuter traffic along the border, but utilize annual data that are not flexible enough to provide insights to short-term dynamic responses to exchange rate policy decisions. By employing higher frequency monthly data, the research at hand attempts to examine commuter flow responses to administrative actions over time.

Subsequent sections of the study are organized as follows. Section two describes the data and methodology. Empirical results are presented in section three. Suggestions for further research are included in the conclusion.

## **DATA AND METHODOLOGY**

The U.S. Customs Service publishes summary statistics regarding northbound bridge traffic in "Monthly Report of Transactions, Port of El Paso." These tables include breakdowns of the number of aircraft, ground vehicles, pedestrians, and total number of people entering the U.S. through El Paso. Data are classified according to point of entry (airport or bridge) and means of transportation. The reports are available from January 1979 and serve as a useful barometer of prevailing business conditions in the international metropolitan area.

Other data used in the time series analysis include the peso/dollar exchange rate, the consumer price index of Mexico, and the consumer price index of the United States. Each variable is recorded at a monthly frequency. All three series were downloaded from the data tapes of the International Monetary Fund. They are available from other sources as well.

To model the number of people crossing the three bridges into El Paso, Texas, two autoregressive integrated moving average (ARIMA) time series techniques are utilized. The ARIMA models are developed using the Box-Jenkins steps of identification, estimation, and diagnostic checking (see Pankratz, 1983). Univariate equations are estimated for each of the bridges and the total number of crossings to see if the series alone contain any predictive power. Systematic testing of this nature is important as high frequency data frequently do not contain easily discernible dynamic behavior patterns. A univariate model of the real exchange rate (REX) is also developed. Real data are used in order to capture the effects of purchasing power shifts only.

Residuals from the univariate commuter series ARIMA equations are then cross correlated over time against residuals from the inflation adjusted peso/dollar exchange rate model. Significant spikes in the cross correlation functions (CCF's) are then used to estimate transfer function ARIMA equations (for details, see Box and Jenkins, ch. 11). The transfer models are used to test whether changes in the number of people using the bridges to reach El Paso can be explained by movements in the real exchange rate.

Using the ARIMA methodologies to model the number of people crossing the border in El Paso allows the data to determine lag structures and model forms. No modeling restrictions are imposed and the signs of the coefficients calculated for the input variables are not hypothesized a priori. This is motivated by the fact that different groups use the bridges for different reasons and may react to changes in the real exchange rate in distinct manners. For example, El Paso businesses observe downturns in the number of Mexican customers following peso devaluations. American tourists, on the other hand, will be attracted to shops and restaurants in Juarez when the exchange value of the dollar is revalued (Phillips, 1996).

In addition to the flexibility offered by ARIMA time series analysis, estimating the equations in this manner is useful because the individual series are autocorrelated. As Granger and Newbold (1974) point out, spurious regressions frequently result from ordinary least squares performed on serially correlated variables. Pierce and Haugh (1977) have shown that transfer functions estimated for such working series will preserve the causal relationships that exist between them. ARIMA models thus offer an efficient method of testing the time series properties of the bridge data.

## **EMPIRICAL RESULTS**

PDN was used by 10.868 million persons and BOTA by 10.481 million people crossing into El Paso in 1987. The two principal points of entry exhibit quite different traffic patterns, however, as the former was traversed by 3.042 million vehicles compared to 4.838 million across the latter. Even more telling, is the fact that nearly 4.838 million pedestrians used the northbound downtown bridge, while only 0.385 million people walked over BOTA. The difference in crossings on foot is undoubtedly related to the proximity of the extensive commercial districts located on both sides of the PDN bridge. The ZARA structure was used by

3.2 million people crossing the border that year, with 1.278 million carriers and 0.265 million pedestrians.

None of the monthly series exhibit nonstationary variances (heteroscedasticity) and, therefore, none are transformed prior to modeling. The BOTA series had to be differenced once in order to induce stationarity. PDN, on the other hand, required no differencing prior to analysis. A working series for the ZARA data was obtained only after regular differencing of degree one and seasonal differencing of degree 12. Similar to the PDN series, TOTAL did not require differencing prior to model identification. Stationarity in the real exchange rate was obtained only after first-order regular differencing. Autocorrelation functions estimated for the stationary components of each series suggested the lags and functional forms for the univariate models tested.

Univariate modeling results for the bridges are summarized in Table 1. Model 1, the univariate BOTA equation, contains moving average terms at lags 1, 3, and 6. A seasonal moving average term is included at lag 12. The equation contains no intercept, indicating that traffic across this bridge is near its saturation level. The lack of a statistically significant constant term reflects an absence of any consistent growth in the mean of the series over the sample period, 1979:01 - 1988:07. All of the estimated coefficients are significant at the 5-percent level, while the Box-Pierce Q-statistic is 18.06, indicating that generated model residuals are random (the chi-square critical value for 30 lags at the 5-percent significance level is 43.8).

**TABLE 1**  
**Univariate Time Series Equations**

Model	Differencing	Intercept	Specification
1. BOTA	1	No	(0;1,3,6) x (0;12)
2. PDN	0	Yes	(1;0) x (12;0)
3. ZARA	1,12	No	(2;1) x (0;12)
4. TOTAL	0	Yes	(1;0) x (12;0)
5. REX	1	Yes	(1;0) x (0;0)

The sample estimation period is 1979.01 - 1988.07.

Three parameters are estimated for the PDN crossings equation (Model 2). An autoregressive term at lag 1 and a seasonal autoregressive term at lag 12 are included along with an intercept. Because these data are not differenced prior to estimation, the constant term in the PDN model does not indicate any growth pattern in mean of the series. The portmanteau Q-statistic, not shown in the table, for this equation is 23.933, implying that the residuals follow a white noise pattern.

The ZARA equation (Model 3) is a mixed model. It has a moving average term at lag 1, an autoregressive coefficient calculated at lag 2, and a seasonal moving average parameter estimated at lag 12. Model 3 does not have a constant term, indicating that there was no upward growth trend in the number of northbound commuter crossings at this point of entry over the sample period under consideration. The Q-statistic for this model is 10.805, implying that the estimated equation does not omit any systematic movements in the dependent variable.

Equation 4 is estimated for TOTAL bridge crossings. It contains an autoregressive term at lag 1, a seasonal autoregressive term at lag 12, an intercept, and moving average terms at lags 4 and 6. The Q-statistic for 30 periods, 25.163, is significant at the 5 percent level and 25 degrees of freedom. Analysis of the residuals autocorrelation function indicated that a moving average term at lag 7 could help the model fit. In fact, the Q-statistic improves when this term is included in the specification. However, there is no apparent reason why seven-month lags should consistently bear the same relationship to current-month bridge traffic. For this reason, as well as parsimony, the original specification is selected despite the higher value associated with its portmanteau test statistic (for a discussion of the importance of parsimony in ARIMA modeling, see Jenkins, 1979).

Model 5 is estimated for the inflation adjusted peso/dollar exchange rate, REX. This equation contains an intercept. Because the working series has been differenced prior to estimation, the inclusion of a constant term reflects systematic real losses in peso-denominated purchasing power over the sample period under consideration. The specification for REX is relatively straightforward, consisting of an autoregressive term at lag 1.

Transfer function modeling results are reported in Table 2. The real exchange rate input variable did not cause any spiking in the ZARA CCF. For the BOTA series, there was significant spiking in the CCF at lags 1 and 8. As shown in Equation 6, parameter estimates for both of those lags are negative, indicating that the net impact of a real devaluation of the peso is to reduce cross-border commuting across this artery. This interpretation must be used with caution, however, because neither of the inflation adjusted exchange rate input coefficients have statistically significant t-statistics associated with them. Inclusion of the REX lags in this equation, and the others where they are utilized, improves the value of the residual Q-statistic for white noise.

PDN cross correlation results also suggest that movements in the exchange rate can help forecast changes in downtown international commuter traffic. All of the parameters calculated for Equation 7 are statistically different from zero. The 2 and 4 month real exchange rate lag coefficients are positive, implying that northbound traffic increases, with a short lag, when the purchasing power of the dollar increases. This may reflect larger numbers of U.S. tourists returning from shopping trips or meals in the commercial district surrounding downtown Juarez.

**TABLE 2**  
**Transfer Function Time Series Equations**

Model	Parameters
6. BOTA	$-0.327*MA(1) - 0.241*MA(3) - 0.203*MA(6) + 0.263*SMA(12)$ <p style="text-align: center;">(3.430)            (2.530)            (2.097)            (2.845)</p> $-0.038*REX(1) - 0.062*REX(8) \qquad Q(30) = 18.573$ <p style="text-align: center;">(0.779)            (1.229)</p>
7. PDN	$1.262 + 0.720*AR(1) + 0.632*SAR(12) + 0.047*REX(2)$ <p style="text-align: center;">(16.80) (9.890)            (7.869)            (2.644)</p> $+ 0.088*REX(4) \qquad Q(30) = 29.844$ <p style="text-align: center;">(3.884)</p>
8. TOTAL	$3.042 + 0.859*AR(1) + 0.620*SAR(12) + 0.098*REX(7)$ <p style="text-align: center;">(10.74) (15.00)            (7.422)            (2.132)</p> <p style="text-align: right;">Q(30) = 40.280</p>

The sample estimation period is 1979.01 - 1988.07.  
Numbers in parentheses are computed t-statistics.

All of the estimated coefficients in Equation 8 carry significant t-statistics. The model includes a 7 month lag of the working series of the real exchange rate as an input to TOTAL monthly crossings. The coefficient is positive, implying that greater dollar purchasing power contributes to larger numbers of people crossing the international bridges in El Paso. This result is intriguing because it indicates that the aggregate impact of a real devaluation is an increase in commuter activity at this border metropolitan area. It is fairly common knowledge that peso devaluations cause retail sector downturns in border communities in the United States. These results imply that increased tourism to Mexico plus higher in-bond assembly plant payrolls outweigh the diminution in bridge traffic associated with reduced Mexican purchasing power impacts (see Phillips, 1996). The data are not categorized according to commuter nationality, making it difficult to more closely examine questions regarding retail customer traffic into the south-central El Paso business district.

## CONCLUSION

This paper examines some of the time series characteristics of northbound bridge crossings from Ciudad Juarez, Chihuahua in Mexico to El Paso, Texas in the United States. There has been a number of studies regarding the response of physical merchandise trade flows to exchange rate policy innovations, but relatively few with respect to commuter traffic across international borders. The data follow systematic patterns over time, permitting univariate ARIMA equations to be successfully estimated for all of the series. For several of the series, significant relationships are also found to exist with respect to the inflation adjusted peso/dollar exchange rate.

Results reported above indicate that northbound bridge traffic to El Paso is nonrandom and follows fairly well defined patterns each year. This fact may be of use to entities such as the U.S. Bureau of Customs, the City of El Paso, public administrative offices in Ciudad Juarez, the respective Chambers of Commerce on both sides of the river, and other organizations that monitor economic trends in the region. Of particular interest is the response of commuter traffic to peso devaluations. The loss in Mexican purchasing power does not, over the sample period analyzed, affect bridge traffic in the eastern portion of the international metroplex in a noticeable manner. In the central region of two cities, where automobile crossings predominate, the impact of a devaluation is negative. In the downtown region of the metro economy, where pedestrian tourism is substantial, the effect is to increase northbound crossings. The aggregate impact is also positive. Of further interest is the fact that in each case, commuter traffic shifts in response to currency valuation changes take place within an 8-month time frame.

Several questions remain to be answered by subsequent research efforts. Of immediate interest is how well the parameter estimates and model specifications reported above will hold up over time. The sample utilized herein only covers the period from January 1979 through July 1988. Since then, significant economic and demographic expansion has occurred on both sides of the river. The latter includes a long-needed upgrade to the easternmost Ysleta-Zaragoza bridge to handle commercial traffic (for discussion, see James and Palmore, 1986). It would also be useful to examine regional business cycle impacts on northbound bridge crossings. Doing so would necessitate incorporating into the transfer function models monthly payroll series for either nonagricultural employment or manufacturing employment in El Paso, as well as monthly maquiladora employment estimates for Ciudad Juarez. From a structural policy perspective, the dismantling of Mexican tariff and nontariff barriers to trade which ultimately led to the adoption of NAFTA may also cause the above model estimates and specifications to become obsolete. Finally, future research efforts may wish to test the forecast properties of the models. Doing so may prove especially useful during transition and recovery periods such as that currently taking place in the aftermath of the December 1994 devaluation.

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