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Purchasing Power Parity: A Time Series Analysis of the U.S. and Mexico, 1995 - 2007

by Steven Yee and Miguel D. Ramirez
September 2015

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Keywords: Exchange Rate; Purchasing Power Parity; Pantula Principle; Johansen Cointegration Test; Grange Causality Test; Zivot-Andrews Single Break Unit

JEL Classification: C10; C22; F30

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Abstract

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Keywords Exchange Rate · Purchasing Power Parity · Pantula Principle · Johansen
Cointegration Test · Grange Causality Test · Zivot-Andrews Single Break Unit
Root Test

JEL C10 · C22 · F30

Introduction

The Law of One Price states that a single identical tradable good should sell for the same price in any two locations when expressed in the same currency, assuming that there are no barriers to trade (i.e. transactions or transportations costs, tariffs, etc.). When this idea is applied to economies as a whole, it is called purchasing power parity (PPP). Absolute PPP states that the exchange rate in the long run is equal to the ratio of price levels between two countries according to Rogoff (1996). If this was not the case, the opportunity for arbitrage would quickly be exploited and parity would be restored. However, there are transactions costs, trade barriers, and plenty of reasons that would prevent a trader from buying a relatively cheap microwave in China and selling it for a profit in the United States. Hence absolute PPP often breaks down in both the short and long run (see Hakkio, 1992).

In its place, the less restrictive relative PPP states changes in the exchange rate tend to offset the difference in price level changes between the two countries. While absolute PPP is a sufficient condition for relative PPP to hold, relative PPP can persist in the absence of absolute PPP (Yarbrough and Yarbrough, 2005).

This paper will investigate whether PPP holds between the United States (U.S.) and Mexico over the 1995-2007 period using quarterly data. The U.S. and Mexico were chosen in part because they both have flexible exchange rates, a necessary condition for PPP. Also, the implementation of NAFTA in 1994 removed most trade barriers and capital restrictions between the U.S. and Mexico according to Neely (1996). Trade between the two countries has also grown at a brisk pace from the pre-NAFTA period to the post NAFTA period (up until 2008).

Blecker (2003) found the relatively high ratio of trade, as a percentage of GDP, between the two nations is indicative of a robust and active trade environment.

Following the peso crisis in 1994-1995, Mexico switched from a managed floating regime to a flexible rate regime in December 1994. Hence the period of study will be 1995 – 2007, before the onset and aftermath of the Great Recession in the U.S. This study utilizes the Johansen and Juselius (1990) cointegration methodology. This paper is unable to draw clear conclusions regarding absolute PPP due to a lack of available data. Relative PPP is supported in the long run, but results are unclear regarding the short run. All conclusions drawn from this study should be considered with some caution as there are some significant limitations with regard to the data, particularly the use of non-seasonally adjusted data and the relatively short time span (Frankel, 1985).

Conceptual Framework

The idea of absolute PPP can be represented by the following equation where e is the exchange rate and $P_{U.S.}$ and P_{MEXICO} are, respectively, the price levels for the U.S. and Mexico:

$$e = P_{U.S.}/P_{MEXICO} \quad (1)$$

Taking the natural log of both sides yields:

$$\ln(e) = \ln(P_{U.S.}) - \ln(P_{MEXICO}) \quad (2)$$

$$\ln(e) = \ln\left(\frac{P_{U.S.}}{P_{MEXICO}}\right) \quad (2a)$$

Thus the first model that will be estimated is

$$\ln(e) = \beta_0 + \beta_1 \ln(P_{U.S.}) - \beta_2 \ln(P_{MEXICO}) \quad (3)$$

If $\beta_1 = -\beta_2$, $\beta_0 = 0$, and $\beta_1 = 1$, then the correctness of absolute purchasing parity is indicated. And equation (3) is equivalent to equation (2). It is clear that equation (3) is written in terms of three variables, thus a VECM will be estimated in line with Johansen (1990). This VECM will provide both a cointegration vector (long run) and error correction results (short run). The first restriction will be applied to the cointegrating relationship.¹ If the restriction holds, then

$$\beta_1 \ln(P_{U.S.}) - \beta_2 \ln(P_{MEXICO}) \quad (4)$$

can be rewritten as

$$\beta_1 \ln\left(\frac{P_{U.S.}}{P_{MEXICO}}\right) \quad (4a)$$

Then equation (2a) can be estimated via a VECM. If the restrictions $\beta_0 = 0$ (no significant constant), and $\beta_1 = 1$ can be applied to the resulting cointegration equation, then absolute PPP will be indicated in the long run. This absolute PPP model builds off of the bivariate cointegration framework of Kim (1992) and Chen (1995). Previous studies indicate strong evidence that absolute PPP does not hold in the short run (see Hakkio, 1992; Frankel, 1985), but a significant and negative error correction term would indicate that short-run equilibrium adjustments do exist.

If absolute PPP is found to hold, this will imply the presence of relative PPP. If absolute PPP does not hold, relative PPP may still exist (Yarbrough and Yarbrough, 2005). Relative PPP can be represented by the following equation:

¹ Using a VECM to initially test for this restriction is a relatively new approach. Previous literature may not have had access to more modern cointegration techniques or may have just assumed the restriction held so that the model could be written in terms of just two variables, the exchange rate and price ratio. See, for example, Chen, 1995; and Ramirez and Khan, 1999.

$$\Delta e = \Delta P_{U.S.} - \Delta P_{MEXICO} \quad (5)$$

If the natural log of each variable is taken, equation (5) can be rewritten as

$$\Delta \ln(e) = \Delta \ln(P_{U.S.}) - \Delta \ln(P_{MEXICO}) \quad (5a)$$

Thus, the first model that will be estimated is

$$\Delta \ln(e) = \beta_0 + \beta_1 \Delta \ln(P_{U.S.}) - \beta_2 \Delta \ln(P_{MEXICO}) \quad (6)$$

A VECM will be estimated since there are three variables in the model. This VECM will provide both a cointegration equation (long run) and error correction results (short run). The restrictions $\beta_0 = 0$, $\beta_1 = -\beta_2$, and $\beta_1 = 1$ will be applied simultaneously to the cointegrating relationship. If the restriction holds, then relative PPP holds in the long run. If the first two restrictions simultaneously hold but the third restriction does not, this will still indicate a trend toward the existence of relative PPP even though equation (5a) is not fully applicable. The error correction results will also be evaluated to determine if relative PPP holds in the short run (i.e. short run equilibrium adjustments do exist).

Data

The data used in this study were obtained from Banco De Mexico, Bureau of Labor Statistics (BLS) and the Federal Reserve Economic Data (FRED) over the period 1995 - 2007. The seasonally unadjusted Mexican PPI data for finished goods were obtained from Banco De Mexico. The data were initially monthly, but they were converted into quarterly data because

PPP is likely to hold over a relatively longer time span. The base period was initially, and is still, December 2003.

Corresponding seasonally unadjusted U.S. PPI data for finished goods were obtained from the BLS. These data were initially monthly, but they were converted into quarterly observations for the same reasons given above for the Mexican PPI. The base period was initially June 1982 (the exact period is not given), before the data were adjusted so the base would be December 2003 to match the Mexican PPI data.

Quarterly exchange rate data regarding the number of American dollars required to purchase a Mexican peso were obtained from the FRED. These data are also not seasonally adjusted. The data were inverted so the exchange rate would be in terms of the Mexican pesos required to purchase an American dollar.

The choice of quarterly data was made to capture the idea that importers and exporters are often locked into contracts that cannot immediately adjust for changes in the exchange rate or price levels. Annual data would have been preferable, but the period in question is too short to obtain a suitable number of annual observations. The relatively short time horizon between observations may prevent the study from correctly analyzing some of the longer run relationships that are thought to exist in purchasing power parity according to Frankel (1985).

Variables

The exchange rate is defined as the number of Mexican pesos required to purchase a U.S. dollar. This time series is obtained by measuring “Noon buying rates in New York City for cable transfers payable in foreign currencies” (FRED, 2015). This study will be looking at the natural log of the exchange rate. This transformation of the variable will allow for much simpler

interpretations of coefficients in the regression analysis. Looking at scatter plots of the raw exchange rate over the observation period suggests a possible logarithmic growth rate over time. This variable was chosen in line with common economic theory on purchasing power parity.

The price level of U.S. finished goods (PPI finished goods) will be used to proxy the price level of a typical basket of tradable goods in the U.S. This time series is obtained by measuring the “average change over time in the selling prices received by domestic producers of goods and services” (BLS, 2015). The price level of Mexican finished goods (PPI finished goods) will be used to proxy the price level of a typical basket of tradable goods in Mexico. Natural logs of both PPI’s were undertaken in order to allow for simpler interpretation of the coefficients. There are also some indications in the scatterplots of the raw data that these time series may have logarithmic growth rates. These variables were chosen because purchasing power parity is a theoretical relationship involving the exchange of goods between countries. Finished goods best match the description of tradable goods given the available data for both Mexico and the United States. Since the exchange rate is defined as pesos per dollar, a higher price of U.S. tradable goods is expected to decrease the number of pesos needed to purchase a dollar, and vice versa for an increase in the Mexican price level. In this context, that would mean a decrease in the exchange rate and an increase in the exchange rate, respectively.

Unfortunately, the Mexican PPI data are not seasonally adjusted in this paper. Seasonally adjusted data regarding the PPI in Mexico were not readily available at the time of this study, hence the exchange rate and U.S. PPI were also chosen to be not seasonally adjusted so as to be consistent throughout the model. This may introduce possible biases into the models as

there may be omitted variables or “causal factors” that act upon our observed series according to Grether and Nerlove (1970). Thus, the results of this study have to be treated with caution before any generalizations can be made to the larger literature regarding PPP.

The use of PPI as a proxy for the price level may also introduce errors into the model. Following Hakkio (1992), in purchasing power parity, “the hypothetical exchange rate equalizes the price of identical market baskets in two different countries.” It is almost certain that the PPI in the U.S. and in Mexico for finished goods do not measure identical market baskets. However, the authors of this study find PPI of finished goods to be a fair proxy given that no price data on such a basket exists. PPI data were chosen over CPI data because the former are a better measure of the price of goods that are actually traded as opposed to the CPI which includes non-tradable good such as housing.

Unit Root Tests

Each of the time series was initially tested for unit roots. This was done so as to avoid the problem of spurious regressions (see Engle and Granger, 1987). The most desirable outcome of unit root tests is for each variable to be integrated of the same order. However, if there is a mix of variables of different orders of integration present, the Johansen and Juselius (1990) cointegration method may still be able to find cointegrating relationships. Augmented Dickey-Fuller (ADF), (HAC corrected) Phillips-Perron (PP), (confirmatory) Kwiatkowski-Phillips-Schmidt-Shin (KPSS), and (single break) Zivot-Andrews (ZA) tests were used to determine the order of integration of each time series. The Dolado et al. (1990) procedure was applied to the use of

these unit root tests. All variables were found to be integrated of either order 0, 1, or 2. The results are as follows.²

Table 1 Stationarity Tests

	Logarithmic level data				First log-difference			
	ADF	PP	KPSS	ZA	ADF	PP	KPSS	ZA
USPPI	1.966	3.778	0.207**	-3.397	-4.133***	-4.330***	0.058	-4.812
MXPPI	-3.720**	-5.225***	0.225***	-6.020***	-	-	0.199**	-
EXCHR	-1.981	-2.035	-0.164**	-3.729	-8.069***	-8.073***	0.049	-9.119***
PRTIO	-5.197***	-6.508***	0.237***	-4.774	-	-	0.195**	-8.703***

*Denotes a significance of 10%, ** stands for 5%, and *** is for 1%

Log U.S. PPI: The ADF, PP, and KPSS tests each found the U.S. PPI (USPPI) to be integrated of order 1. The ZA test found the U.S. PPI to be integrated of order 3. The ZA result does not make sense in looking at the raw data. Further, the consistency of the other three tests will be weighed more heavily so this study finds the U.S. PPI to be integrated of order 1. Looking at a scatter plot of the raw data, there appears to be an upward trend so this result is not surprising. Thus the difference of the log of the American PPI is integrated of order 0.

Log Mexican PPI: The ADF, PP, and ZA tests indicated Mexican PPI (MXPPI) to be integrated of order 0. The confirmatory KPSS test indicated the Mexican PPI to be integrated of order 2, but the consistency in the more powerful PP and ZA test results are given more weight here. This result is somewhat surprising given that the raw data appear to indicate an upward trend. Thus the difference log of the Mexican PPI is integrated of order 0.

² The ZA test was conducted using Model C and 4 lags since the data are quarterly. All tests were conducted at the 5% significance level. Full tests and results (i.e. constant, trend, etc.) are available upon request.

Log Exchange Rate: The ADF, PP, KPSS, and ZA tests all indicate the exchange rate (EXCHR) is integrated of order 1. This result is not surprising given the raw data appear to indicate an upward trend. Thus the difference of the log of the exchange rate is integrated of order 0.

Log (U.S. PPI/ Mexican PPI): The ADF and PP tests indicated the log of the price ratio (PRTIO) is integrated of order 0. The KPSS and ZA tests indicated integration of order 2 and order 1 respectively. In this case, the study will defer to the ADF and more powerful PP test results so that the log of the price ratio is integrated of order 0.

Cointegration Analysis

Three basic models were tested using the Pantula Principle (1989). The latter methodology chooses the appropriate specification of the model regarding the deterministic components of the equation. The procedure compares the trace and the Max-Eigen statistics of Models 2,3, and 4 (in this order) to their critical values starting from the most restrictive model (no cointegration) to the least restrictive one ($n - 1$ cointegrating vectors), and stops when the null hypothesis of no cointegration cannot be rejected for the first time.

Model 1

Variables: $\log(\text{EXCHR})$, $\log(\text{USPPI})$, $\log(\text{MXPPI})$ (1)

Given that there are many tests to conduct and models to estimate--and VEC models are sensitive to the number of lags included--this study first determined the appropriate lag length. This was done comparing VAR specifications with 1 - 4 lags. Unfortunately, further testing for more lags could not be conducted due to relatively limited number of observations (52) and large loss of degrees of freedom. Based on the Schwarz Bayesian Criterion, the optimal number of lags was 1. This result is somewhat surprising given that the data are quarterly, so the

expected number of lags was 4. This may be indicative of the fact that the observation time span from 1995 – 2007 is not sufficiently long to identify some of the longer run relationships in the data.

Once the number of lags is identified, the Johansen and Juselius cointegration method for multivariate models was applied following the Pantula Principle.

Table 2 Johansen test results

R	Trace statistics			Max - Eigen statistics		
	Model 2	Model 3	Model 4	Model 2	Model 3	Model 4
0	57.475 (35.193)	38.983 (29.797)	56.167 (42.915)	36.131 (22.230)	25.058 (21.132)	29.999 (25.823)
1	21.244 (20.262)	13.925* (15.495)	26.169 (25.872)	16.337 (15.892)	13.815* (14.265)	18.713 (19.387)
2	4.907 (9.165)	0.111 (3.841)	7.456 (12.518)	4.907 (9.165)	0.111 (3.841)	7.456 (12.518)

Table 2 reports the Trace and Max-Eigenvalue statistics of the Johansen cointegration test for the three relevant models. The test is conducted on the logarithmic series. R stands for the number of cointegrating vectors and the 5 % critical values of the tests are in parenthesis. Model 2 includes a constant but no trend in the cointegration equation (CE) and does not allow a trend in the VAR part of the test equation. Model 3 allows an intercept, but no trend in both the CE and the VAR parts of the test equation. Model 4 includes an intercept in both the CE and VAR, a trend in the CE, but no trend in the VAR.

The cointegration results indicated that Model 2 (with an intercept in the cointegrating vector, but not in the VAR) with two cointegrating equations was most appropriate to proceed with when using a VECM. However, based on the T-statistics of one of the included cointegrating equations, one equation was not significant at the 5% level (excluding the constant). This finding led the study to proceed to use model 2 with a single cointegrating equation.

Table 3 Normalized unrestricted cointegration coefficients

	EXCHR	USPPI	MXPPI	C
Cointegration coefficients t-ratios	1.000	-1.138 [-3.747]	0.974 [10.564]	3.034 [2.786]

Table 4 Normalized restricted cointegration coefficients

	EXCHR	USPPI	MXPPI	C
Cointegration coefficients	1.000	-0.932	0.932	-30.828

In Table 4, the resulting VECM in Table 3 was then tested to see if the restriction $\beta_{U.S.} = -\beta_{MEXICO}$ held in the cointegrating equation. The p-value for the Wald LR restriction test was 0.470, indicating that the null hypothesis of the restriction could not be rejected at the 5% significance level. This restriction indicates that the ratio of American PPI to Mexican PPI can be treated as a single variable in the model, as opposed to two separate variables as indicated in (1). Thus the model was rerun as follows to test directly for absolute PPP:

Model 2

Variables: $\log(\text{EXCHR})$, $\log(\text{PRTIO})$ (2)

Since the log of exchange rate and the log of the price ratio were found to be integrated of order 1 and order 0, respectively, it is not possible to proceed with further tests for cointegration--in the case of two variables--because the behavior of the non-stationary series $I(1)$ will dominate the behavior of the stationary $I(0)$ one (see Engle and Granger, 1987), thus generating spurious results. Although it is not possible to test directly for the existence of absolute PPP between the United States and Mexico due to data limitations and anomalies, the existence of a unique cointegrating relationship in Model 1 above gives indirect evidence for

the existence of absolute PPP in the case of the U.S. and Mexico. It is therefore expected that relative PPP will hold for the two countries, to which we turn in Model 3 below.

Model 3 (Δ indicates the change in the variable)

$$\text{Variables: } \Delta \log(\text{EXCHR}), \Delta \log(\text{USPPI}), \Delta \log(\text{MXPPI}) \quad (3)$$

Since there are three variables in the model, the Johansen and Juselius cointegration method must be used. All three variables were found to be integrated of order 0, as noted in the variables section. The appropriate number of lags was found to be 1, based on SBC from VARs with 1 – 4 lags. Applying the Pantula Principle, following the trace statistic criteria, indicates that model 4 with two cointegrating equations should be used to estimate a VECM.

Table 5 Johansen test results

R	Trace statistics			Max - Eigen statistics		
	Model 2	Model 3	Model 4	Model 2	Model 3	Model 4
0	57.953 (35.193)	57.139 (29.797)	65.409 (42.915)	33.959 (22.300)	33.926 (21.132)	36.783 (25.823)
1	23.995 (20.262)	23.212 (15.495)	28.625 (25.872)	15.570* (15.892)	15.484 (14.265)	17.228 (19.387)
2	8.424* (9.165)	7.728 (3.841)	11.397 (12.518)	8.424 (9.165)	7.728 (3.841)	11.397 (12.518)

Table 5 reports the Trace and Max-Eigenvalue statistics of the Johansen cointegration test for the three relevant models. The test is conducted on the differences of the logarithmic series.

However, once the VECM was estimated, the trend was not significant in one cointegrating equation and the Mexican PPI was not significant in the other cointegrating equation. These results led the study to consider using the Pantula Principle based on the max eigenvalue criteria. This indicated model 4 should be used with a unique cointegrating equation. The following restrictions were applied to both the VAR and cointegrating equations: $\beta_{\text{EXCHR}} = \beta_{\text{USPPI}}$,

$\beta_{USPPI} = -\beta_{MXPPI}$, $\beta_{USPPI} = 1$, and $Trend = 0$. The resulting p-value was 0.077, indicating that the restriction appears to be valid at the 5% significance level.

Table 6 Normalized restricted cointegration coefficients

	D(EXCHR)	D(USPPI)	D(MXPPI)	TREND	C
Cointegration coefficients	1.000	-1.000	1.000	0.000	-0.008

Table 7 Restricted error correction model

	D(EXCHR)	D(USPPI)	D(MXPPI)
Error correction coefficient	-1.345	0.000	0.000
Standard Error	-0.226	(0.000)	(0.000)
t-statistics	[-5.945]	[NA]	[NA]
R-squared	0.601	0.194	0.160
Adj. R-squared	0.565	0.120	0.083
Akaike AIC	-3.389	-6.246	-5.677
Schwarz SBC	-3.196	-6.053	-5.484

The corresponding VECM indicates a significant (t-statistic = -5.95) and negative (-1.35) adjustment coefficient on the difference of the log of the exchange rate. This coefficient can be interpreted as the difference between the expected log of the price ratio and the actual log of the price ratio in the previous period decreases by 135% each year. This result is very surprising given that other studies have indicated that the exchange rate can be slow to adjust to changes in price levels in the short run. The validity of the restrictions indicate that both the difference in the log of both price levels are weakly exogenous at the 5% level. Individual tests for weak exogeneity were conducted amongst the variables and the results (see Table 8) were consistent with those of the general restricted ECM indicated in Table 7.

Table 8 Exogeneity test

H0: weakly exogenous variable	Chi-Square statistics (49 obs)	Probability
D(EXCHR), A(1,1)=0	14.174	0.000
D(USPPI), A(2,1)=0	2.479	0.115
D(MXPPI), A(3,1)=0	0.481	0.488

Table 9 Granger block test on restricted model

Null Hypothesis	Probability
D(USPPI) does not Granger-cause D(EXCHR)	0.211
D(MXPPI) does not Granger-cause D(EXCHR)	0.007
D(EXCHR) does not Granger-cause D(USPPI)	0.663
D(MXPPI) does not Granger-cause D(USPPI)	0.984
D(EXCHR) does not Granger-cause D(MXPPI)	0.742
D(USPPI) does not Granger-cause D(MXPPI)	0.501

Granger Block causality tests on the restricted model find Granger causality from the Mexican price level to the exchange rate at the 5% level (see Table 9), but no other Granger causal relationships. It is surprising that a similar relationship was not found between the U.S. price level and the exchange rate given the results of the Wald test indicating weak exogeneity. There is also serial correlation (indicated at the 5% level by an LM test³) in the restricted model that did not appear in the unrestricted model. The lack of consistency with previous studies as well as the conflicting Granger Block results and the weak exogeneity tests prevent this study from making any definitive claims on whether relative PPP holds in the short run.

From the long-run relationship indicated by the cointegration equation in Table 6, when the change in the U.S. price level increases by one percent, the change in the exchange rate decreases by one percent, holding all other variables constant. When the change in the

³ Results of the LM test are available upon request.

Mexican price level increases by one percent, the change in the exchange rate increases by one percent, holding all other variables constant. However, there is a negative constant (-0.0082) in the equation. This constant may indicate that there are some fixed trade barriers that prevent relative PPP from holding more closely. This negative constant indicates that the long run exchange rate is lower (i.e. the dollar is undervalued) than what would be expected under relative PPP. However, the constant is nearly 0, which, along with the other long run coefficients, indicates that relative purchasing parity does appear to hold fairly closely in the long run between the U.S. and Mexico.

Conclusion

The first model initially considered three separate variables: the log of exchange rate, the log of the U.S. PPI, and the log of the Mexican PPI. A unique cointegrating relationship was found between the three variables. Further, a restriction on the cointegrating relationship that the ratio of the log of the U.S. PPI to the log of the Mexican PPI could be treated as a single variable, as opposed to two separate variables, could not be rejected. The second model then attempted to directly test the relationship between the log of the exchange rate and the log of the price ratio. However, the log of the exchange rate was found to be $I(1)$ while the log of the price ratio was found to be $I(0)$. Hence no further tests for cointegration could be conducted. Although the first model presents indirect evidence that absolute PPP may hold in the long run, due to data limitations, this relationship could not be tested directly. Thus it is not clear if absolute PPP holds in the long run between the U.S. and Mexico. Given that relative PPP is a necessary, but not sufficient condition for absolute PPP, the third model tests the relationship between the

change in the log of the exchange rate, and the changes in the log of the U.S. PPI and Mexican PPI. Here, a lack of relative PPP would indicate that absolute PPP could not hold.

Although the unrestricted third model does not indicate relative PPP in the cointegrating relationship, valid restrictions were imposed such that relative PPP does appear to hold fairly tightly in the long run. These restrictions ensure all coefficients in the long run relationship have the expected signs and correct magnitudes, but a very small constant is present in the model, which prevents true theoretical relative PPP from holding. Further valid restrictions were imposed on the error correction model such that the U.S. and Mexican price levels appear to be weakly exogenous. This represents a positive contribution over previous studies that fail to test for valid restrictions on both the cointegrating vectors and the adjustment coefficients of the VECM.

However, these results were in conflict with a Granger Block causality test that only indicated Granger causality from the Mexican price level to the exchange rate, and no other Granger causal relationships. The negative and significant adjustment coefficient on the exchange rate was also greater than 1 in absolute value, which is unrealistic given that observations for this study are only quarterly, not even yearly. This directly conflicts with previously noted studies that indicated much more than a year was needed for disturbances in PPP to dissipate. This lack of consistency in the short-run results prevents this study from drawing any conclusions regarding relative PPP in the short run.

As already mentioned, this study has some limitations that need to be addressed by future researchers. First, seasonally adjusted data were not available for the Mexican PPI. As a result, none of the data used are seasonally adjusted. This could introduce possible biases into all

models estimated. Thus, the analysis should be re-estimated once seasonally adjusted data are available. Second, although the number of observations is above the recommended threshold of 50, the time span is only from 1995 – 2007. This may be too short of a period to assess the potential long-run relationships among the time series. This also necessitated the conversion of the observations to quarterly (from monthly observations) units so that large sample tests could be undertaken for univariate unit root tests which are known for their low statistical power (i.e. failing to reject a false null hypothesis). While this study clearly has its limitations, it lays the empirical framework for future tests of PPP between the U.S. and Mexico.

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