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Purchasing Power Parity in Mexico: A Historical Note

by

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Abstract: Purchasing Power Parity in Mexico: A Historical Note
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Purchasing power parity has been the subject of many empirical studies. Much of this work has focused on recent history in developed countries. This paper reports results of tests for nonlinear, mean reversion of the real exchange rate for a less-developed country, Mexico, using a previously unexploited data set of monthly observations for 1930-1960. The test results provide weak support for PPP.

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Introduction

Purchasing power parity (PPP) means that the cost of a market basket of goods is the same in different countries when measured in a common currency. If barriers to trade are absent, there are no transportation costs, and the goods in the market basket are traded and not subject to price controls, then deviations from PPP are temporary and eliminated through arbitrage. That is, the real exchange rate will revert to its mean, generally assumed to be the purchasing power parity value. But empirical evidence for mean reversion of the real exchange rate has not been overwhelming. Indeed, Taylor and Taylor (2004) cite the absence of strong empirical support as one of two puzzles concerning PPP.[1] The second puzzle is the very slow adjustment speeds to PPP based on supportive evidence obtained assuming linear adjustment.

Taylor (2001) shows how linear estimates of adjustment speeds can be biased upward when the true process is nonlinear.[2] Taylor and Taylor cite three reasons for nonlinear adjustments: Transactions costs, heterogeneity of opinion in foreign exchange markets, and the tendency of central banks to intervene only when the deviation of the real exchange rate from its (presumed) fundamental value is large. Transactions costs, for example, can produce a band or range within which arbitrage is not profitable so that the real exchange rate behaves as a unit root process. However, once the real

[1] See Sarno y Taylor (2002) for a comprehensive survey of the evidence before 2002.
[2] The upward bias can be compounded by the degree of temporal aggregation in the data, as demonstrated in Taylor. A comprehensive review of the literature on nonlinear adjustment is beyond the scope of this note. As a start,

exchange rate moves outside the band's upper or lower threshold, the rate tends to return to its threshold value.[3]

This paper reports results of tests for a nonlinear unit root in the real exchange rate for Mexico, relative to the US dollar, during the 1930-1960 period. The nonlinear unit root test is one developed by Sollis, Leybourne, and Newbold (2002), henceforth SLN.

Historical Review and Data

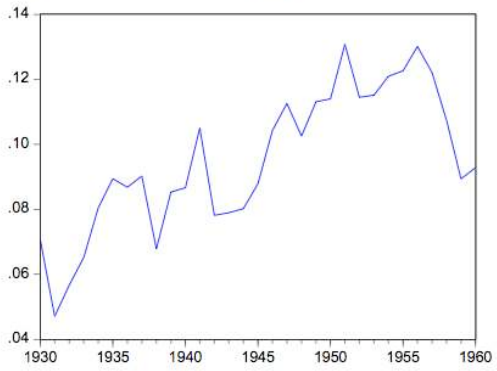
The period considered in this paper was a tumultuous one in the world economy as it includes the Great Depression and World War II, and these events most certainly impacted Mexico. According to data in Cárdenas (1987) real per capita GDP declined from approximately 2,553 pesos in 1926 to 1,775 pesos in 1932.[4] Total GDP decreased sharply as well. Internal events also affected the economy. Gold was demonetized in 1931, as was silver four years later. The peso was allowed to float in 1932, and then subsequently fixed in value in November 1933. Indeed, during the entire period considered in this study the data show that nominal exchange rates were generally fixed; but these periods of generally fixed rates are interspersed with devaluations and brief interludes of floating rates. The government also began to take a more active, interventionist role in the economy in pursuing various social objectives. For example Haber (1989) cites instances in the 1920s when textile manufacturers were denied permission to shut down failing factories in order to maintain employment,

[3] The gold points under the gold standard are an example of such threshold values which have long been recognized. In studies of the law of one price Sarno, Taylor, and Chowdhury (2004) and Juvenal and Taylor (2008) find that transactions costs are sizeable and vary substantially across countries and sectors.

[4] The peso depreciated during this period so that the decline in per capita GDP is even more dramatic when expressed in dollars; from about $1239 to $562.

a policy that continued at least into the 1930s.[5] In 1938 the oil industry was nationalized. Not least, Mexico pursued an import substitution strategy in the 1950s as can clearly be seen in Figure 1 showing imports as a percent of GDP. Import substitution policies continued well into the 1980s. The other noticeable declines in imports were associated with the Great Depression, the expropriation of the oil industry in 1938, and World War II.

Figure 1-Imports as a Percentage of GDP, Mexico 1930-1960



The data used in the study are from Cárdenas (1994) and include monthly observations on the nominal exchange rate, measured as the Mexican peso price of a US dollar, and the wholesale price index in Mexico City.[6] These data have not been used previously to study purchasing power parity. The US producer price index, not seasonally adjusted, for the same period is from the database, FRED, maintained by the St. Louis Federal Reserve Bank.

Test Specification and Results

Letting p_t^M represent the log wholesale price index in Mexico, p_t the log US producer price index, and e_t the log price of one US dollar in

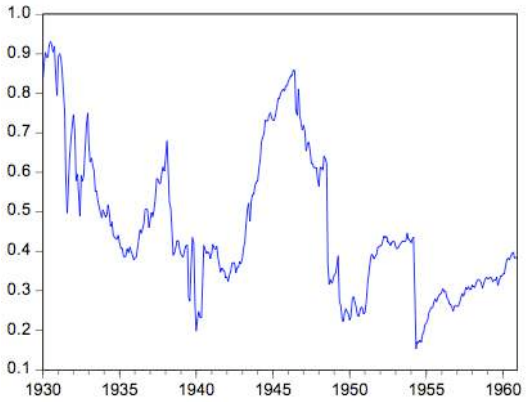
[5] Haber, pp. 157-158.
[6] Price indices are not available for the entire country. Mexico City was, and remains, the most important commercial and industrial location in the country.

Mexican pesos, the log of the period t real exchange rate is given by equation (1).

$$r_t = p_t^M - e_t - p_t \qquad (1)$$

Figure 2 shows the real exchange rate over the sample period.

Figure 2-Log Real Exchange Rate, Mexico
January 1930 to December 1960



One approach to testing for purchasing power parity is to test r_t for the presence of a (linear) unit root. The absence of a unit root is evidence of mean reversion, usually regarded as evidence of reversion to its PPP value.[7] A series of linear unit root tests are applied to the full sample and the January 1930-December 1951 and January 1952-December 1960 subsamples. The subsamples are selected to isolate the period of import substitution, a period in which PPP is less likely to hold due to diminished trade. In most cases, the linear tests fail to find evidence of stationarity.[8] There are no indications of seasonality in the data; the mean real exchange rate is virtually the same each month despite substantial variation in r_t over

[7] Conceptually, it is possible that the real exchange rate reverts to a mean different from its PPP value. See the discussion in Taylor and Taylor.

[8] Results from the augmented Dickey-Fuller test over the full sample, the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test over the restricted sample January 1930-December 1951, and the and Elliot, Rothenberg, and Stock (ERS) over the subsample January 1952-December 1960 are supportive of PPP. Over the full sample the stationarity null for the KPSS test is cannot be accepted at the 1% level nor does the ERS test show evidence of stationarity over the full sample. Results from the Phillips-Perron unit root tests regardless of sample period fail to support stationarity of the real exchange rate.

the sample, so that the possibility of seasonal unit roots do not need to be considered.

Given the low power of linear unit root tests when the adjustment process is nonlinear, investigation of an alternative nonlinear approach seems warranted. Furthermore, the tendency of Mexico to maintain a fixed nominal exchange rate with devaluations at irregular intervals suggests a nonlinear adjustment process for the real exchange rate. A test developed by Sollis, Leybourne, and Newbold (2002), henceforth SLN, based on the smooth transition, autoregressive (STAR) model is employed. The underlying idea is that mean reversion will be an increasing function of squared deviations from the mean. The SLN test offers two advantages. First, it permits asymmetric adjustment so that the response to an overvalued exchange rate can be different from the adjustment of an undervalued one. Second, the test can carried out allowing for different delays in the adjustment response. Such delays might arise if, say, over a lengthy period of time the central bank expended foreign reserves in a futile effort to maintain a fixed rate and resorted to devaluation only after reserves fell below some minimum target.[9] The symmetric version of the test is given by equation (2)

$$\Delta z_t = \alpha\left\{-.5 + \left[1 + \exp\left(-\gamma^2 z_{t-d}^2\right)\right]^{-1}\right\} z_{t-1} + \sum_{i=1}^{k} \beta_i \Delta z_{t-i} + \varepsilon_t \qquad (2)$$

where z_t is the demeaned real exchange rate and the term in braces is a modified logistic function. The sample mean is used to construct the

[9] Even though a central bank might implement a discrete devaluation once the real exchange rate is outside its target range, the prices of individual, traded goods can also adjust to move the real exchange rate in the direction its PPP value. Since individual goods are likely to have different threshold values due to different transactions costs, a test based on a STAR model is more appropriate than, say, a threshold autoregressive model in which the adjustments are abrupt.

demeaned real exchange rate.[10] It is helpful to note that the SLN test is the equivalent to the augmented Dickey-Fuller test when the term in braces is equal to one. The delay parameter is an integer, $d \geq 1$, that can be varied to allow for responses to squared deviations of the demeaned real exchange rate further in the past, and the number of lags, k, is selected so that ε_t is a white noise process. Of interest is the t-statistic on the estimated value of α. If the estimated α is significantly different from zero, the nonlinear unit root null cannot be accepted thus providing evidence of PPP.

Versions of equation (2) are estimated using nonlinear least squares for different values of d. The estimated values of the coefficients, α and γ, are hardly affected by the choice of d, but the significance of the estimated α is sensitive to d as reported below. To determine k, lags of the dependent variable are added to the test equation until the marginal significance level of the obs.*R^2 statistic from a Lagrange multiplier test exceeds .3. By this criterion, 7 lags of Δz_t are included in the estimations. As a check on this conclusion estimations are also carried out with 9 lags of Δz_t. Using a Wald test the null hypothesis that the coefficients on lags 8 to 9 are jointly equal to zero cannot be rejected and none of the extra lags have individually significant coefficients. The number of lags needed to eliminate autocorrelation is not affected by changes in the delay parameter.

Various specification were tried allowing for asymmetric adjustment of the real exchange rate, but none showed any evidence of different responses to over-valued and under-valued real rates. Hence, test results are reported

[10] See SLN for additional discussion of the test equation. In particular, the symmetric version of the test is valid when the data are demeaned using the sample mean rather than the population mean.

solely for the symmetric case. Table 1 displays the t-statistics for the estimated α in the SLN nonlinear test allowing for different delays and seven lags of the dependent variable. The number varies with the value of d, but there are at least 361 observations for each specification. Based on simulations, SLN report a 10% critical value of -2.86 for the t-statistic when there are 300 observations.[11] As the critical value is hardly affected by the number of observations, it is -2.83 for 500 observations, -2.86 is used to assess significance of the estimated α from equation (2).

Table 1 t-statistics from the SLN Unit Root Test Applied to the Real Exchange Rate for Mexico, January 1930 to December 1960.

Delay parameter	t-statistic
1	-2.610
2	-2.540
3	-2.538
4	-2.575
5	-2.771
6	-2.772
7	-2.770
8	-2.867*
9	-2.743
10	-2.912*
11	-2.625

*10% significance level

As can be seen from the results in the table, except for two of the specifications, those with delay parameters of 8 and 10 months, the unit root null cannot be rejected thus providing evidence against purchasing power parity. But it is interesting to note that none of the t-statistics for delay parameters ranging from one to eleven months are very different, they are all clustered in from -3 to -2.5. Those that are not significant are reasonably

[11] See Table 1 of their paper.

close to the 10% critical value. Interpreted in this fashion, the results seem to provide some weak support for PPP. Interestingly, when SLN apply their tests to monthly real exchange rates with respect to the U.S. dollar for seventeen countries not a single t-statistic is significant from the symmetric version of the test. Indeed, all but two of the t-statistics they report for the symmetric version are larger than -2.5.

Examined in a different light, however, the fact that even two of the nonlinear unit root test results are supportive of PPP could be considered remarkable in light of the sample period. As noted earlier the years 1930-1960 include a relatively long period during which import substitution policies were followed, nominal exchange rates were usually fixed, and the peso was devalued periodically; conditions that make the it more difficult to uncover evidence of PPP. In light of these complicating factors, any evidence of mean reversion can be considered surprising.

Furthermore, that the significant t-statistics appear on specifications with delays of 8 and 10 months is consistent with central bank behavior during this period. Cárdenas cites such instances when foreign exchange reserves were expended to maintain the nominal exchange and the government resorted devaluation and brief periods of floating rates when the decline in reserves could not be halted.[12]

Conclusions

Considering the difficulties of uncovering evidence of mean reversion during a period of mostly fixed nominal rates with occasional devaluations, the fact that two specifications yield t-statistics indicating stationarity of the

[12] For example see the discussion on pages 49 and 101-102.

real exchange rate and all the estimated t-statistics are close to their 10% critical value suggests that PPP probably did hold in Mexico during the 1930-1960 period. The failure to find any indications of asymmetric adjustment may be due to its absence or may be explained by the fact that peso does not appear to have been over-valued often during the period.

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