

Price Adjustments Patterns in Mexico and The United States

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<https://doi.org/10.62345/jads.2016.5.4.1>

Abstract

This study utilizes Engel-Granger's (1987) cointegration methodology to investigate the adjustment patterns of prices in Mexico and the U.S. The empirical findings reveal discrepancies in the magnitudes of speed-of-adjustment coefficients between Mexican and US prices. The results also indicate that the adjustment of Mexican price relative to that of the U.S. seems to be lower in the NAFTA era, as compared to that of earlier periods. This phenomenon would seemingly contradict the conventional wisdom and may be attributable to the fact that, in the NAFTA era, the smaller Mexican economy has been well-integrated into the larger U.S. economy, with its price level's slowly following that of the U.S.

KeyWords: Real exchange rate, speed-of-adjustment, purchasing power parity.

Introduction

Since the early 1960's, Mexico's economy has experienced some periods of sustained economic growth. Between 1960 and 1980, the Mexican economy grew at an average annual rate of over 6.5 percent, resulting in significant improvements in per capita gross domestic product (GDP) and living standards during that time period. In the ensuing years, however, the average real GDP growth dropped due to the 1982 debt crisis, which resulted in productivity growth's falling to negative numbers. Economic reforms introduced in the latter part of the 1980's helped stimulate economic growth, resulting in average annual GDP growth of 3.8 percent between 1990 and 1994. At the culmination of this process, Mexico entered into NAFTA with Canada and the United States. NAFTA is an agreement signed by Canada, Mexico, and the United States, enacted on January 1, 1994, that established a trilateral trade bloc in North America (Villarreal, 2010.)

At the end of 1993, Mexico was considered a model for developing countries. Five years of prudent fiscal and monetary policy had dramatically lowered Mexico's budget deficit and inflation rate, and the government had privatized many enterprises that were formerly state-owned. But less than a year after the implementation of NAFTA, in December 1994, investors began liquidating their peso-denominated assets, causing the value of the Mexican peso to plunge 50.0 percent against the U.S. dollar. Mexico was

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The authors **acknowledge** the valuable contributions of our Department Chair, Dr. Chu Nguyen, in providing Model Specifications and Econometric Analysis for this article. These contributions have immensely added to the depth and strength of this article.



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forced to borrow from the International Monetary Fund (IMF) and the United States in order to weather the ensuing financial crisis. In 1995, inflation in Mexico soared to 50.0 percent and real GDP fell by 4.0 percent (Neely, 1996.)

The historical Mexican exchange rate policy, before the enactment of NAFTA, finds that Mexico had pursued a managed flexible float regime from August 5, 1985 to November 10, 1991; an exchange rate bands with managed slippage approach from November 11, 1991 to December 21, 1994; and a free float system from December 22, 1994 to present.

Yee and Ramirez (2016) found indirect evidence that absolute purchasing power parity (PPP) may hold in the long-run between the U.S. and Mexico but the relationship could not be tested directly because of data limitations. NAFTA increasingly tied Mexico to the U.S. economy at a time when the U.S. economy was becoming dependent on growth driven by asset bubbles. As a result, Mexico suffered a recession when the U.S. stock market bubble burst (an event which lasted from 2000-2002) and was one of the hardest-hit countries in the region during the Great U.S. Recession, experiencing a drop of 6.7 percent of GDP. The Mexican economy was even harder hit by the peso crisis, triggered by the U.S. Federal Reserve's raising interest rates in 1994, which caused the GDP to fall by 9.5 percent during the downturn.

The Mexican economy's vulnerability to developments in U.S. financial markets continued. In May of 2013, after the U.S. Federal Reserve announced a future "tapering" of its quantitative easing program (QE1, QE2, and QE3), there were fears of a repeat of the 1994 peso crisis, and gross foreign portfolio inflows came to a sudden stop. The Mexican economy suffered a setback, with projected growth at only 1.22 percent for the year. This was mostly because, as the IMF noted, "Mexico's deep and liquid foreign exchange and domestic equity and sovereign bond markets can serve as an early port of call for global investors in episodes of financial turbulence and hence are susceptible to risks of contagion," a vulnerability that resulted from the very policies that NAFTA was designed to address (Weisbrot et al., 2014).

As aforementioned, the above cyclical movements would, no doubt, cause oscillations in Mexican price levels and, hence, inflation rate differentials between Mexico and the United States. Under relative purchasing power parity (PPP), the differential inflation rates in the economies of two trading partners must be exactly offset by changes in the respective nominal exchange rates so that the two countries' competitive positions will be unaffected (Eun and Resnick, 2015). Therefore, it is of special interest to investigate the patterns of price adjustments between these two neighboring countries, Mexico and the U.S.

Methodology

To study the adjustment pattern of the Mexican exchange rates, let E_t , P_t^f , and P_t denote the logarithms of the price of foreign currency (exchange rate), the foreign price level, and the domestic price level; the long-run purchasing power parity (PPP) requires that $E_t + P_t^f - P_t$, which is known as real exchange rate, be stationary. As articulated by Enders (2015), if PPP holds, the sequence formed by the sum $\{E_t + P_t^f\}$ should be cointegrated with the $\{P_t\}$ sequence. Following Enders' (2015) and Hamilton's (1994) precedent to define the domestic currency value of the foreign price level, $F_t = E_t + P_t^f$, long-run PPP asserts that there exists a linear combination of the form $F_t = \beta_0 + \beta_1 P_t + \mu_t$ such that $\{\mu_t\}$ is stationary and the cointegrating vector is such that $\beta_1 = 1$.

The next step in the investigation process is to estimate the long-run equilibrium relationship by regressing $F_t = E_t + P_t^f$ on P_t ,

$$F_t = \beta_0 + \beta_1 P_t + \mu_t \quad (1)$$

Theoretically, the absolute PPP asserts that $F_t = P_t$; therefore, the absolute version of the Purchasing Power Parity requires that $\beta_0 = 0$ and $\beta_1 = 1$. However, the relative version of the PPP only requires that domestic and foreign price levels be proportional to each other, i.e. F_t is required to be proportional to P_t . This, in turn, implies that β_0 may be different from zero. As pointed out by Enders (2015), Engle and Granger included an intercept term in their original Monte Carlo simulations.

Enders (2015) also noted that, in equation (1), it is not assumed that P_t is the exogenous variable while F_t is the dependent variable or that the $\{\mu_t\}$ sequence is white noise. Therefore, it is not appropriate to conclude that the estimated value of β_1 is significantly different from unity just because the value of $(1-\beta_1)$ exceeds two or three standard deviations.

To proceed in the investigation process, the residuals from the regression model, described by equation (1) and denoted by $\{\hat{\mu}_t\}$, are checked for unit root. It is also important to note that $\{\hat{\mu}_t\}$ are the residuals from a regression equation; therefore, they have a zero mean and do not have a time trend. In this analysis, the following two equations (2) and (3) are specified and estimated using the residuals from the estimated long-run equilibrium relationship described by equation (1).

$$\Delta \hat{\mu}_t = \alpha_1 \hat{\mu}_{t-1} + \varepsilon_t \quad (2)$$

and

$$\Delta \hat{\mu}_t = \alpha_1 \hat{\mu}_{t-1} + \sum \alpha_{i+1} \Delta \hat{\mu}_{t-i} + \varepsilon_t \quad (3)$$

In this model specification, and hence forth, Δ denotes “the periodic change in,” i.e. $\Delta \hat{\mu}_{t-i}$ is the change in $\hat{\mu}_t$ from one period to another. Econometrically, failure to reject the null hypothesis $\alpha_1 = 0$ means that the null hypothesis of no cointegration cannot be rejected. Additionally, under the null hypothesis $\alpha_1 = 0$, the critical values for the t-statistic depend on sample size. Alternatively, if $-2 < \alpha_1 < 0$, it is possible to conclude that the $\{\hat{\mu}_t\}$ sequence does not have a unit root and that the $\{F_t\}$ and $\{P_t\}$ sequences are cointegrated.

The final step in Engle and Granger’s methodology is to specify and estimate the error-correction model in the form of equations (4) and (5). The χ^2 or F-tests can be used to determine the lag length of the model. The estimated coefficients of the model may be used to examine the adjustment patterns of the exchange rates when they are pushed off their long-run equilibrium trends, known as their convergences.

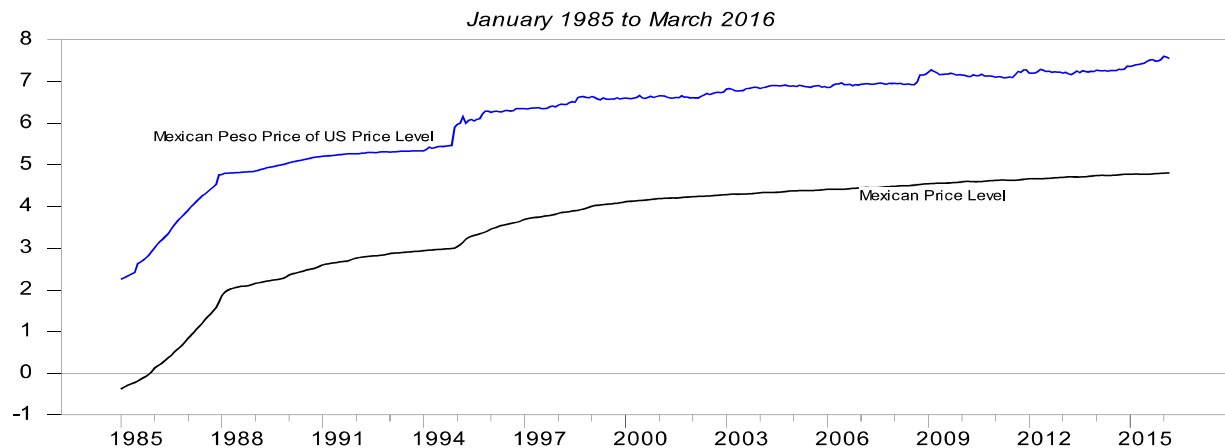
$$\Delta F_t = \varphi_0 + \varphi_1 \hat{\mu}_{t-1} + \sum_{i=1}^M \delta_i \Delta F_{t-i} + v_t \quad (4)$$

$$\Delta P_t = \rho_0 + \rho_1 \hat{\mu}_{t-1} + \sum_{j=1}^N \theta_j \Delta P_{t-j} + \varsigma_t \quad (5)$$

Data and Empirical Results

One of the issues in empirical studies of developing and emerging economies is the availability of data. This investigation utilizes available monthly data on Mexican peso-U.S. dollar exchange rates, all-items consumer price indices in the economies of Mexico and the United States from January 1985 to November 2015. All time series were extracted from the International Financial Statistics database, published by the International Monetary Fund, and they were then expressed in logarithms.

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Note: Data was from the International Financial Statistics, published by the IMF

Empirical Results

As aforementioned, the above cyclical movements in many macroeconomic variables would no doubt cause fluctuations in Mexico's price level and, hence, an inflation rate differential between Mexico and its trading partners in general and with the U.S. in particular. Under relative purchasing power parity (PPP), the differential inflation rates in the two economies must be exactly offset by changes in the respective nominal exchange rates so that the two countries' competitive positions remain unaffected (Eun and Resnick, 2015); therefore, it is of special interest to determine whether the adjustment patterns of prices in the US and Mexico differ in their long-term trends in the pre- and post-NAFTA eras.

In order to achieve the above objective, this study stratifies the sample period into two sub-periods: January 1985 to December 1993 and January 1994 to the end of the sample period. Equations (1) through (5) will be estimated using data from the two subsamples as well as from the entire sample. The estimation results will be analyzed in order to assess the adjustment patterns of the prices in Mexico and the U.S.

Exhibit 2: The Equilibrium Regression Results, Equation (1), Monthly Data

Period	Jan. 1985 – Dec. 1993	Jan. 1994 – Mar. 2016	Jan. 1985 – Mar. 2016
Estimated β_1	0.869181	0.927727	0.920994
Standard error	(0.013881)	(0.013736)	(0.005025)

Note: standard deviations are in parentheses.

Exhibit 3 summarizes the estimation results of equations (2) and (3). As aforementioned, failure to reject the null hypothesis $\alpha_i = 0$ means that the null hypothesis of

no cointegration cannot be rejected. Alternatively, as articulated by Enders (2015), if $-2 < \alpha_i < 0$, it is possible to conclude that $\{\hat{\mu}_t\}$ sequence does not have a unit root and that $\{F_t\}$ and $\{P_t\}$ sequences are cointegrated.

Exhibit 3: Dickey-Fuller Tests of the Residuals, Equations (2) and (3); Monthly Data

Period	Jan. 19 85 – Dec. 1993	Jan. 1994 – Mar. 2016	Jan. 1985 – Mar. 2016
No lags:			
Estimated α_1	-0.038150	-0.079377	-0.047846
Standard error	(0.017213)	(0.023658)	(0.015586)
<i>t</i> -statistic for $\alpha_1 = 0$	-2.21630	-3.355150	-3.069830
Up to 12 lags			
Estimated α_1	-0.046844	-0.043253	-0.045669
Standard error	(0.018725)	(0.020377)	(0.016183)
<i>t</i> -statistic for $\alpha_1 = 0$	-2.501760	-2.12263	-2.822070

Note: standard deviations are in parentheses

A close look at the empirical results summarized in Exhibit 3 reveals that all estimated values of α_i 's are between -2 and 0. This finding suggests that the Mexican peso values relative to the US price level and the Mexican price level are cointegrated.

Exhibit 4: Speed of Adjustment from Disequilibrium, Equations (4) and (5): Renminbi

	Constant	Coefficient of $\hat{\mu}_{t-1}$
1985 - 1993		
Estimation of ΔF_t	0.007467	-0.009685
Standard error	(0.004079)	(0.023094)
$F_{(k,l)}$ testing the null hypothesis $H_0 : \sum_{i=1}^M \delta_i = 0$; $F_{(2,101)} = 27.82957^*$		$H_0 : \delta_1 + \delta_2 = 0$
Estimation of ΔP_t	0.004310	0.017918
Standard error	(0.002004)	(0.010167)
$F_{(k,l)}$ testing the null hypothesis $H_0 : \sum_{i=1}^N \theta_i = 0$; $F_{(1,103)} = 264.463683^*$		$H_0 : \theta_1 = 0$

1994 - 2016

Estimation of ΔF_t	0.004156	- 0.076543
Standard error	(0.002752)	(0.026992)
$F_{(k,l)}$ testing the null hypothesis $H_0 : \sum_{i=1}^M \delta_i = 0$; $F_{(6,259)} = 6.00856^*$ $H_0 : \delta_1 + \delta_3 + \delta_4 + \delta_5 + \delta_9 = 0$		
Estimation of ΔP_t	0.001062	0.012956
Standard error	(0.000415)	(0.002946)
$F_{(k,l)}$ testing the null hypothesis $H_0 : \sum_{i=1}^N \theta_i = 0$; $F_{(4,260)} = 137.13888^*$ $H_0 : \theta_1 + \theta_4 + \theta_7 + \theta_{12} = 0$		

1985 - 2016

Estimation of ΔF_t	0.002442	-0.052034
Standard error	(0.002332)	(0.019636)
$F_{(k,l)}$ testing the null hypothesis $H_0 : \sum_{i=1}^M \delta_i = 0$; $F_{(4,359)} = 16.91631^*$ $H_0 : \delta_1 + \delta_3 + \delta_5 + \delta_9 = 0$		
Estimation of ΔP_t	0.001022	0.014937
Standard error	(0.000512)	(0.003741)
$F_{(k,l)}$ testing the null hypothesis $H_0 : \sum_{i=1}^N \theta_i = 0$; $F_{(5,356)} = 301.04372^*$ $H_0 : \theta_1 + \theta_2 + \theta_5 + \theta_6 + \theta_{11} = 0$		

Note: “*” indicates significance at 1 percent level.

The estimation results summarized in Exhibit 4 are analyzed below in order to study the adjustment patterns of the prices in the U.S. and Mexico.

Discussion

A careful analysis of the estimation results for equations (4) and (5), using two sub samples and the full sample data set, reveals that, on the strength of the F-statistics, each estimated equation of the error vector correction model retained some lagged dependent variables ΔF_t or ΔP_t . The point estimates of the coefficients of independent variable $\hat{\mu}_{t-1}$, in all three estimations indicate direct but slow convergence to long-run equilibria. For example, over the entire sample period, in the presence of one-unit deviation from long-run PPP in period $t-1$, the U.S. price level (converted to Mexican peso) falls by 0.052034 units and the Mexican price level rises by 0.014937 units. These two price changes in period t act to partially close the positive discrepancy from long-run PPP present in period $t-1$. A negative discrepancy would precipitate adjustments in these variables in the opposite directions.

It is also interesting to note that, in addition to differences in discrepancies in the magnitudes of speed-of-adjustment coefficients, in the absolute values, not only between Mexican and US prices, the speed-of-adjustment coefficients seem to be different in the NAFTA era as compared to those of earlier periods. For the pre-NAFTA era, the Mexican price adjusted to its long-run PPP, relative to that of the U.S., faster than that of the Mexican peso price of the US price level, i.e. $0.017918/0.009685 = 1.85$ times faster, which is consistent with the long held idea that the United States was larger country relative to Mexico—movement in U.S. prices evolved independently of events in Mexico; but movements in Mexican prices responded to events in the United States. However, in the post-NAFTA era, this relative figure is $0.012956/0.076543=0.1693$. These empirical findings in

post NAFTA contradict the long-held conventional wisdom, which may be attributable to the new economic reality that the smaller Mexican economy has been well-integrated into the larger U.S. economy, and its price level slowly follows that of the US.

Concluding Remarks

Mexico's economy has experienced some periods of sustained economic growth between 1960 and 1980. Over this period, the Mexican economy grew at an average annual rate of over 6.5 percent, resulting in significant improvements in per capita gross domestic product and living standards during that time period. Five years of prudent fiscal and monetary policy had dramatically lowered Mexico's budget deficit and inflation rate, and the government had privatized many enterprises that were formerly state-owned. At the end of 1993, Mexico was considered a model for developing countries. However, less than a year after the implementation of NAFTA, investors began liquidating their peso-denominated assets, causing the value of the Mexican peso to plunge 50.0 percent against the U.S. dollar.

These cyclical movements in many macroeconomic variables would no doubt cause oscillation fluctuations in Mexican price level and, hence, an inflation rate differential between Mexico and the US. Under relative purchasing power parity, the differential inflation rates in the two economies must be exactly offset by changes in the respective nominal exchange rates so that the two countries' competitive positions will be unaffected; therefore, it is of special interest to determine whether long-term trends to the adjustment patterns of prices in the US and Mexico differ in the pre- and post-NAFTA eras.

The empirical results indicate direct but slow convergence to long-run equilibria. Additionally, in the absolute values, the speed-of-adjustment coefficients of Mexican price seem to be lower in the NAFTA era as compared to earlier periods. This phenomenon contradicts conventional wisdom and may be attributable to the fact that, in the NAFTA era, the smaller Mexican economy has been well-integrated into the larger US economy, and its price level slowly follows that of the US.

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