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Mexico's Integration into NAFTA Markets: A View from Sectoral Real Exchange Rates*

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Abstract

Using a threshold autoregressive model, we confirm the presence of nonlinearities in sectoral real exchange rate (SRER) dynamics across Mexico, Canada and the US in the pre-NAFTA and post-NAFTA periods. Measuring transaction costs using the estimated threshold bands, we find evidence that Mexico still faces higher transaction costs than their developed counterparts. Trade liberalization is associated with reduced transaction costs and lower relative price differentials among countries. Other determinants of transaction costs are distance and nominal exchange rate volatility. Our results show that the half-lives of SRERs shocks, calculated by Monte Carlo integration, imply much faster adjustment in the post-NAFTA period.

Keywords: NAFTA, Law of One Price, Exchange Rates, Nonlinearities, SETAR
JEL Classification: F31; F36; F41.

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1 Introduction

The analysis of relative price differentials across countries and sectors offers a way to evaluate the degree of market integration. The law of one price (LOOP) states that identical goods should sell for the same price across countries when prices are expressed in a common currency. Evidence has shown, however, that prices of goods fail to fully equalize between countries, indicating that markets are not perfectly integrated.

Prices of homogeneous goods tend to differ across countries because the presence of transaction costs limits price arbitrage. Obstacles to integration include transport costs and (explicit or implicit) trade barriers.

The study of the LOOP among NAFTA members is of particular interest, allowing an assessment of whether regional trade liberalization has resulted in faster price convergence and smaller price differentials across countries and greater market integration.

This paper concentrates on three issues. First, we assess the degree of market integration among the US, Mexico and Canada by analyzing the validity of the LOOP between these country pairs. Second, we determine whether markets became more integrated, with reduced transaction costs, after the introduction of NAFTA. Finally, we analyze whether transaction costs are related to economic determinants.

Our study focuses on the role of transaction costs in modeling deviations from the LOOP. Several theoretical studies (see Dumas, 1992; Sercu et al., 1995; O'Connell, 1998) show that because of transaction costs, it may not be profitable to arbitrage away relative price differences across countries when the marginal costs of arbitrage exceed the marginal benefit. This will generate a band of no trade where prices in two locations will fail to equalize. Outside this threshold band, arbitrage is profitable and the sectoral real exchange rate (SRER) can become mean-reverting. This dynamic implies nonlinearities in SRERs and is well captured by using a threshold autoregressive (TAR) model for each sectoral relative price (see Tong, 1990; and Hansen, 1996, 1997). The TAR model allows for deviations from the LOOP to exhibit unit root behavior inside the threshold band and to become mean-reverting outside the band. If there is no mean reversion in the outer regime, relative prices fail to equalize between countries, a sign of weak market integration. In this way, the estimated threshold bands provide a measure of transaction costs.

The empirical methodology analyzes dynamics in relative price adjustment and innovates by taking the perspective of an emerging market – Mexico.[1] Motivated by previous literature we investigate the presence of threshold-type nonlinearities in deviations from the LOOP using monthly real dollar sectoral exchange rates vis-à-vis the Mexican peso and the Canadian dollar and monthly real exchange rates for Mexico vis-à-vis Canada for 18 sectors. The period considered is 1980-2006. Nonlinearities are captured using a self-exciting threshold autoregressive model (SETAR).

More precisely, we estimate SETAR models for each SRER for the pre-NAFTA and post-NAFTA periods. The outcome of this estimation contains a measure of transaction costs (threshold band) and the autoregressive parameter outside the band. We determine whether deviations from the LOOP show mean-reverting properties by testing whether the nonlinear specification is superior to a nonstationary model for each subsample. This requires testing whether the autoregressive process outside the band is significantly different from the random walk observed inside the band. We also test whether the threshold bands are significantly wider for each SRER in the pre-NAFTA and post-NAFTA periods, thus allowing assessment of whether NAFTA led to higher market integration.

The results show that transaction costs are larger for the Mexico-US and Mexico-Canada country pairs than for the Canada-US pair, thus suggesting a higher degree of market integration between the US and Canada. We also find that NAFTA significantly reduced transaction costs and price differentials between the US and Mexico, although this was not uniform across sectors. Finally, our estimated transaction costs are negatively related to trade liberalization, commonly shared geographic borders, and lower exchange rate volatility.

As a measure of the speed of mean reversion we compute the half-life, which is the time it takes for the effects of half of a shock to dissipate, using generalized impulse response functions (see Koop et al., 1996). We find that half-lives are substantially reduced after the introduction of the NAFTA, especially for the Mexico-US country pair. This implies that reduced arbitrage costs were accompanied by faster adjustments in price differentials.

The remainder of the paper is organized as follows. Section 2 reviews theoretical considerations on nonlinear dynamics in SRERs and presents the corresponding econometric methodology. The results are discussed in Section 3. We present a battery of robustness tests in Section 4. Section 5 concludes.

[1] There is now an established literature on nonlinear behavior of sectoral real exchange rates for developed markets (see Obstfeld and Taylor, 1997; Imbs et al., 2003; Sarno et al., 2004 and Juvenal and Taylor, 2008).

2 Nonlinearities: Motivation and Empirical Framework

According to the LOOP, there should be no price differentials across countries for similar goods when prices are expressed in a common currency. At the aggregate level, the LOOP translates into purchasing power parity (PPP). The LOOP is based on the assumption of frictionless goods arbitrage. This means that there are no impediments to trade or transaction costs that would prevent perfect arbitrage.

Ample empirical evidence (Isard, 1977; Richardson, 1978 and Giovannini, 1988) suggests that relative prices do not converge, or only in a very long-term horizon, and that price differentials are persistent. These studies also found that relative price differentials are significant and highly correlated with exchange rate movements.

One reason that prices of homogeneous commodities may not be the same across different countries is the existence of transaction costs arising from transport costs, tariffs, and nontariff barriers.[2] A number of theoretical papers suggest the importance of transport and trade barriers in creating price differences between countries (e.g. Dumas, 1992; Sercu et al., 1995; O'Connell, 1998). The models described in such studies have incorporated different assumptions regarding the nature of trade costs. Overall, price differences driven by transaction costs can be expressed as $S^i P^i_j = P^R_j + A_j$, where S^i is the nominal exchange rate between country i's currency and the reference country, P^i_j is the price of good j in country i, P^R_j is the price of good j in the reference country, and A_j is the marginal transaction cost. In particular, A_j shows the minimum price difference that makes arbitrage profitable between country i and the reference country. In the presence of perfectly competitive markets, constant returns to scale technology, and absence of sellers pricing power, price differences that are higher than the transaction costs will be arbitraged. Thus,

$$-A_j \leq S^i P^i_j - P^R_j \leq A_j. \tag{1}$$

In this framework, transaction costs generate two regimes: (i) when price differentials are smaller than transaction costs, there is a regime of no arbitrage described by (1); (ii) when price differences exceed transaction costs, arbitrage is profitable and equation (1) does not hold. This implies that price differentials behave in a nonlinear fashion. Within the

[2] Heckscher (1916) first pointed out at the possibility of nonlinearities in relative prices in the presence of trade frictions. In the case of Mexico, González and Rivadeneyra (2004) investigate the LOOP between Mexican cities and provide empirical evidence that transactions costs (including tariff and non-tariff barriers) explain departures from the LOOP.

transaction costs band (or threshold band) price differentials follow a nonstationary process, and outside the band they are mean reverting toward the band because of the effects of arbitrage.

The condition expressed in equation (1) can be written in terms of each SRER as

$$1 - \frac{A_j}{P_j^R} \leq \frac{S^i P_j^i}{P_j^R} \leq 1 + \frac{A_j}{P_j^R}, \tag{2}$$

where $\frac{S^i P_j^i}{P_j^R}$ is the SRER between country i's currency and the reference country for good j. The condition in (2) implies that the transaction costs band and nonlinearities are good and country specific.

Based on the previous theoretical framework, a number of empirical studies analyze the nonlinear nature of deviations from the LOOP in terms of a TAR model (Tong, 1990). The TAR model allows for the presence of a threshold band within which arbitrage is not profitable. Consequently deviations from the LOOP follow a unit root process. Outside the band the process can become mean-reverting.

Recent contributions that use this model to analyze SRER dynamics of developed markets include Obstfeld and Taylor (1997), Sarno et al. (2004), Imbs et al. (2003), and Juvenal and Taylor (2008). In particular, Obstfeld and Taylor (1997) find evidence of nonlinearities in a sample of 32 locations, using disaggregated data on clothing, food, and fuel. Sarno et al. (2004) provide support for nonlinear mean reversion with considerable cross-country and sectoral heterogeneity. They use annual price data interpolated into quarterly data for nine sectors and quarterly data on five exchange rates vis-à-vis the US dollar. Juvenal and Taylor (2008) study the presence of nonlinearities in deviations from the LOOP for 19 sectors in 10 European countries and find significant evidence of threshold adjustment with transaction costs varying considerable across sectors and countries.

2.1 Empirical framework

2.1.1 Data

We use disaggregated monthly data on consumer price indices (CPIs) for 18 sectors from January 1980 to December 2006 for Mexico, the US and Canada. Data on CPIs were obtained from the Bank of Mexico, the U.S. Bureau of Labor Statistics and Statistics Canada. The sectors analyzed are: bread (*bread)*, meat (*meat*), fish (*fish*), dairy (*dairy*), fruits (*fruits*), vegetables (*veg*), nonalcoholic beverages (*nonalco*), alcoholic beverages (*alco*), tobacco (*tobac*), women's clothing (*clothw*), men's clothing (*clothm*), footwear (*foot*), fuel (*fuel*), furniture (*furniture*), medication (*medic*), vehicles (*vehicles*), gasoline (*gasoline*), and photographic equipment (*photo*). Table 1 lists the sectors analyzed in this study and the description of the category for each country. Monthly nominal exchange rates are period averages from the International Financial Statistics (IFS) of the International Monetary Fund (IMF).

2.1.2 Model

To analyze patterns in relative price convergence, we model deviations from the LOOP using a SETAR model for each sectoral exchange rate. More precisely, we investigate the presence of nonlinearities in deviations from the LOOP using a threshold-type model with two regimes.

In what follows, we proceed in four steps. First, we estimate TAR models for each SRER. Second, we explore the validity of the nonlinear threshold model with respect to a null hypothesis of unit root process. This allows us to test for the existence of some degree of price convergence as opposed to no price convergence at all.[3] Third, when we find evidence that a nonlinear specification is superior to a nonstationary model, we determine whether price convergence is characterized by an asymmetric threshold adjustment consistent with arbitrage arguments. That is, we test whether a nonlinear model fits the data better than a stationary linear one. Finally, when we find evidence of nonlinear price convergence in the pre-NAFTA and post-NAFTA periods, we test if the size of the threshold band is equal in both periods.

The existence of transaction costs, in the form of transport costs or trade barriers, is one explanation for lack of price convergence. As described before, frictions to trade imply the presence of significant nonlinearities in SRER dynamics. That is, transaction costs generate a band in which the marginal costs of arbitrage exceed the marginal benefit. Within this band, there is a zone of no trade and consequently prices in two locations fail to equalize. Outside

[3] A failure to reject the unit root hypothesis implies that deviations from the LOOP are a uniform unit root process and thus, prices in two locations are disconnected. This test allows identification of any difference in the autoregressive parameters between the inner band and the outer band regimes. This test is an important addition to the methodology generaly used in the literature. Earlier studies directly test for nonlinearity with respect to a linear model but do not determine whether the outer regime is nonstationary. An exception is found in Peel and Taylor (2002), who present a procedure to test for unit root to study covered interest parity. We use the procedure developed by Enders and Granger (1998) to test for the null hypothesis of nonstationarity against an alternative of stationarity with threshold adjustment.

this band, arbitrage is profitable and the SRER can become mean-reverting. Empirically, this pattern is described by a TAR model, which was originally popularized by Balke and Fomby (1997) in the context of testing for PPP and the LOOP.

Let x^i_{jt} be the deviation from the LOOP for a sector j in country i at time t, defined as follows

$$x^i_{jt} = s^i_t + p^i_{jt} - p^R_{jt}, \tag{3}$$

where s^i_t is the logarithm of the nominal exchange rate between country i's currency and the reference country, p^i_{jt} is the logarithm of the price of good j in country i at time t, and p^R_{jt} is the logarithm of the price of good j in the reference country at time t.

A simple three-regime TAR model may be written as

$$\begin{aligned}
q^i_{jt} &= \alpha q^i_{jt-1} + \varepsilon^i_{jt} \text{ if } \left|q^i_{jt-d}\right| \leq \kappa && (4)\\
q^i_{jt} &= \kappa(1-\rho) + \rho q^i_{jt-1} + \varepsilon^i_{jt} \text{ if } q^i_{jt-d} > \kappa && (5)\\
q^i_{jt} &= -\kappa(1-\rho) + \rho q^i_{jt-1} + \varepsilon^i_{jt} \text{ if } q^i_{jt-d} < -\kappa && (6)\\
\epsilon^i_{jt} &\sim N(0,\sigma^2), && (7)
\end{aligned}$$

where q^i_{jt} is the demeaned component of the relative price difference x^i_{jt} given by $x^i_{jt} = c^i_j + q^i_{jt}$ (q^i_{jt} is estimated as an OLS residual), κ is the threshold parameter[4], and q^i_{jt-d} is the threshold variable for sector j and country i. The parameter d accounts for the delay with which economic agents react to real exchange rate deviations.

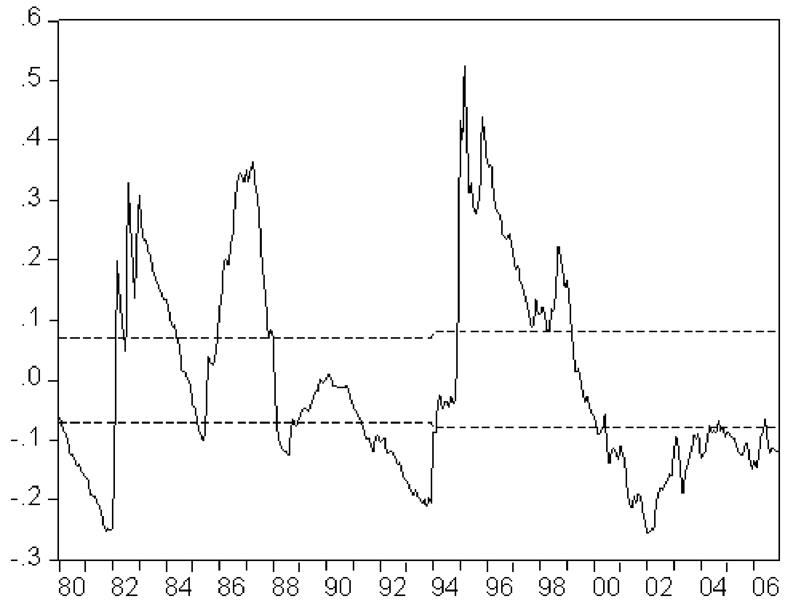
In what follows, we restrict the value of α to unity, so inside the band deviations from the LOOP are persistent and follow a random walk.[5] Outside the band, when $\left|q^i_{jt-d}\right| > \kappa$, the process becomes mean-reverting as long as $\rho < 1$. The model described is a TAR (1, 2, d), where 1 is the autoregressive order, 2 represents the number of thresholds, and d is the delay parameter. Further, because the threshold variable is assumed to be the lagged dependent variable, the model is called SETAR (1, 2, d) with the given parameters.

An example of the estimated model is presented in Figure 1. The graph contains the time series for q^i_{jt} (solid line), which represents the demeaned real exchange rate between Mexico and the US for the footwear sector and the estimated κ (dashed lines).

[4]Note that κ is country and sector specific.

[5]This restriction is widely used in the literature (see Obstfeld and Taylor, 1997; Imbs et al., 2003; Sarno et al., 2004; and Juvenal and Taylor, 2008).

Figure 1. Footwear real exchange rate and threshold bands



2.1.3 Estimation

Using indicator functions $1\left(q^i_{jt-d} > \kappa\right)$ and $1\left(q^i_{jt-d} < -\kappa\right)$, which take the value of 1 when the inequality is satisfied, the model in equations (4)-(7) can be simplified to equation (8):

$$\Delta q^i_{jt} = \left[(\rho - 1)\left(q^i_{jt-1} - \kappa\right)\right] 1\left(q^i_{jt-d} > \kappa\right) + \left[(\rho - 1)\left(q^i_{jt-1} + \kappa\right)\right] 1\left(q^i_{jt-d} < -\kappa\right) + \varepsilon^i_{jt}. \quad (8)$$

Note that the model in (8) is assumed to be symmetric. Thus, deviations from the LOOP outside the threshold band are the same regardless of whether prices are higher in the US or in another country. This specification assumes that reversion is toward the edge of the band.

Let us rewrite equation (8) as

$$\Delta q^i_{jt} = B^i_{jt}(\kappa, d)'\Gamma + \epsilon^i_{jt}, \quad (9)$$

where $B^i_{jt}(\kappa, d)'$ is a (1×2) row vector that describes the behavior of Δq^i_{jt} in the outer regime and Γ is a (2×1) vector containing the autoregressive parameters to be estimated. More precisely,

$$B_{jt}^{i}(\kappa,d)' = \left[\begin{array}{cc} X'1\left(q_{jt-d}^{i} > \kappa\right) & Y'1\left(q_{jt-d}^{i} < -\kappa\right) \end{array} \right], \tag{10}$$

where

$$\begin{aligned} X' &= [q_{t-1} - \kappa] \\ Y' &= [q_{t-1} + \kappa] \end{aligned}$$

and

$$\Gamma' = \left[\begin{array}{cc} \rho - 1 & \rho - 1 \end{array} \right]. \tag{11}$$

The parameters of interest are Γ, κ, and d. Equation (8) is a regression equation nonlinear in parameters which can be estimated using least squares. For a given value of κ and d, the least-squares estimate of Γ is

$$\widehat{\Gamma}\left(\kappa,d\right) = \left(\sum_{t=1}^{T} B_{jt}^{i}(\kappa,d) B_{jt}^{i}(\kappa,d)'\right)^{-1} \left(\sum_{t=1}^{T} B_{jt}^{i}(\kappa,d)\Delta q_{jt}^{i}\right), \tag{12}$$

with residuals $\widehat{\epsilon}_{jt}^{i}(\kappa,d) = \Delta q_{jt}^{i} - B_{jt}^{i}(\rho,d)'\widehat{\Gamma}\left(\kappa,d\right)$, and residual variance

$$\widehat{\sigma}^{2}(\kappa,d) = \frac{1}{T}\sum_{t=1}^{T}\widehat{\epsilon}_{jt}^{i}(\kappa,d)^{2}. \tag{13}$$

Because the values of κ and d are not given, they should be estimated together with the autoregressive parameter ρ. Hansen (1997) suggests a methodology to identify the model in equation (9) that consists of the simultaneous estimation of κ, d, and ρ via a grid search over κ and d. The model is estimated by sequential least squares for values of d from 1 to 6. The values of κ and d that minimize the sum of squared residuals are chosen. The range for the grid search is selected to contain the 15th and 85th percentile of the threshold variable. This can be written as

$$\left(\widehat{\kappa},\widehat{d}\right) = \underset{\kappa\in\Theta,\ d\in\Psi}{\arg\min}\,\widehat{\sigma}^{2}\left(\kappa,d\right), \tag{14}$$

where $\Theta = \left[\underline{\kappa},\overline{\kappa}\right]$.

The least-squares estimator of Γ is $\widehat{\Gamma} = \widehat{\Gamma}\left(\widehat{\kappa}, \widehat{d}\right)$ with residuals $\widehat{\epsilon}^i_{jt}\left(\widehat{\kappa}, \widehat{d}\right) = \Delta q^i_{jt} - B^i_{jt}(\widehat{\kappa}, \widehat{d})'\widehat{\Gamma}\left(\widehat{\kappa}, \widehat{d}\right)$ and residual variance $\widehat{\sigma}^2\left(\widehat{\kappa}, \widehat{d}\right) = \frac{1}{T}\sum_{t=1}^{T}\widehat{\epsilon}^i_{jt}\left(\widehat{\kappa}, \widehat{d}\right)^2$.

2.1.4 Testing Procedures

Before explaining the results, it is important to test if the TAR-type nonlinear model is superior when tested against a unit root process and against a linear AR(1) process. These tests require pre-estimation of both the linear model under the null hypothesis and the TAR model under the alternative.

First, we test if the SETAR specification is superior to a unit root process for each SRER employing the Enders and Granger (1998) threshold unit root test.[6] The method is a generalization of the Dickey-Fuller test. The null hypothesis is

$$H_0^A : \rho = 1$$

against an alternative of stationarity with threshold adjustment. This test allows identification of any difference in the autoregressive parameters between the inner and outer regimes. Its main advantage is that it is generally more powerful than the Dickey-Fuller test. A failure to reject the unit root null implies that the LOOP does not hold and prices in two locations are disconnected. We interpret this as conveying that transaction costs are so high that the entire series are included within the threshold bands. Thus, the inner and outer regimes cannot be distinguished.

When the null hypothesis of unit root is rejected, we continue with our analysis. Our second step is to test a linear AR(1) specification against a nonlinear stationary SETAR. Let β be the autoregressive parameter implied by the linear AR(1). The null hypothesis of linearity is

$$H_0^B : \beta = \rho.$$

[6] Other tests for the null of unit root against a nonlinear model have been proposed in the literature. Recent contributions include Kapetanios and Shin (2006) and Bec et al. (2008). In particular, Kapetanios and Shin (2006) propose a Wald statistic to test a unit root null against a three-regime SETAR process. Bec et al. (2008) develop a more general procedure that consists of an adaptive threshold SupWald unit root test. We emphasize that the decision to use the Enders and Granger (1998) test does not represent a criticism of other methods. Overall, simulations have not provided evidence in favor of one test or another and this analysis is beyond the scope of our paper.

In cases in which we find evidence of nonlinearities in the pre-NAFTA and post-NAFTA periods, we test if the size of the threshold band is equal in both periods. Let τ_j^i be the name assigned to the threshold variable in the post-NAFTA period and θ_j^i be the threshold variable in the pre-NAFTA period. The null hypothesis is

$$H_0^C : \tau_j^i = \theta_j^i.$$

As noted in Hansen (1997), testing hypotheses H_0^B and H_0^C is not straightforward. A statistical problem is present because conventional tests have asymptotic nonstandard distributions. To overcome inference problems, the asymptotic distribution of the conventional F-statistic must be calculated using Monte Carlo simulation. Following Hansen (1997) and Peel and Taylor (2002), if the errors are *iid* the null hypothesis H_0^B and H_0^C can be tested using the statistic

$$F_T(\kappa, d) = T\left(\frac{\widetilde{\sigma}^2 - \widehat{\sigma}^2(\kappa, d)}{\widehat{\sigma}^2(\kappa, d)}\right), \tag{15}$$

where F_T is the F-statistic when κ and d are known, T is the sample size, and $\widehat{\sigma}^2(\kappa, d)$ and $\widetilde{\sigma}^2$ are the unrestricted and restricted estimates of the residual variance. Hence, $\widehat{\sigma}^2(\kappa, d)$ is obtained from the unconstrained nonlinear least-squares estimation of equation (8) and $\widetilde{\sigma}^2$ results from the estimation of equation (8) with the restriction to be tested imposed.

Because κ and d are not identified under the null hypothesis, the distribution of $F_T(\kappa, d)$ is not χ^2. Hansen (1997) shows that the asymptotic distribution of $F_T(\kappa, d)$ may be approximated using the following bootstrap procedure: (i) generate $y_{jt}^{i*}, t = 1, ..., T$ from *iid* $N(0, 1)$ random draws; (ii) set $q_{jt}^{i*} = y_{jt}^{i*}$; (iii) using $q_{jt-1}^i$for $t = 1, ..., T$, regress y_{jt}^{i*} on q_{jt-1}^i and estimate the restricted and unrestricted models and obtain the residual variances $\widetilde{\sigma}^{*2}$ and $\widehat{\sigma}^{*2}(\kappa, d)$, respectively; (iv) with these residual variances, it is possible to calculate the following F-statistic:

$$F_T^*(\kappa, d) = T\left(\frac{\widetilde{\sigma}^{*2} - \widehat{\sigma}^{*2}(\kappa, d)}{\widehat{\sigma}^{*2}(\kappa, d)}\right). \tag{16}$$

The bootstrap approximation to the asymptotic p-value of the test is calculated by counting the number of bootstrap samples for which $F_T^*(\kappa, d)$ exceeds the observed $F_T(\kappa, d)$.

3 Estimation Results

3.1 Testing for nonlinearity

Tables 2A, 2B, and 2C report the results of the estimation of the SETAR model for the Mexico-US, Canada-US and Mexico-Canada country pairs, respectively. The first step consists of testing the null hypothesis of a unit root using the Enders and Granger (1998) threshold unit root test. Essentially, this allows us to determine whether the autoregressive process is the same outside and inside the threshold band. A failure to reject the null hypothesis implies that the SRER is nonstationary and consequently prices in two locations are disconnected. Thus, the LOOP does not hold. Our interpretation of such a case is that transaction costs are so large that arbitrage is not profitable and the threshold band is wide enough to contain the entire time series of the SRER.

For the Mexico-US country pair, the test rejects the unit root null hypothesis in half of the series for the pre-NAFTA period. By contrast, in the post-NAFTA period nonstationarity is found in four of the sectors. We interpret these results as evidence that NAFTA has been associated with greater integration between the US and Mexico.

The behavior of relative prices between Mexico and Canada shows a similar pattern even though the degree of market integration has not improved as much in the post-NAFTA period as in the case of the US and Mexico.

The deviations from the LOOP in the Canada-US country pair show a different behavior. The unit root null is rejected in 73 percent of the series in the pre-NAFTA period and in all the series except one in the post-NAFTA period. These results suggest that the Canadian and American markets have been more closely integrated, with a slight improvement with NAFTA.

To further test for the validity of the SETAR model, the second step consists of testing whether the nonlinear model is superior to a linear AR(1) process applying the Hansen test described in the previous section. We conduct this test only for cases in which the Enders and Granger (1998) test rejects the unit root null.[7] Our results show that the outcomes of the Hansen test are in line with the results of the Enders and Granger (1998) test. In the cases in which the Enders and Granger (1998) test finds evidence of threshold behavior, the Hansen test rejects the linear null hypothesis.

[7] The Hansen test requires that the series are stationary; this is why we apply this test only for the series in which the unit root null is rejected.

At a sectoral level a few points should be highlighted. For the Mexico-US country pair, there is evidence of unit root in bread, which is a low-cost subsidized food sector; in sectors that are subject to intervention through taxation, such as alcoholic and nonalcoholic beverages; and in a sector with a high degree of differentiation such as furniture. Interestingly, nonstationary behavior is found in sectors such as gasoline and fuel, which are characterized by a high degree of monopolistic power. Similarly, for the Mexico-Canada country pair there is evidence of unit root in gasoline and bread, further suggesting the potential role of specific regulations in leading to price differences.

In the Canada-US country pair, nonstationary behavior is present in a sector subject to government intervention such as tobacco and in clothing and footwear. By contrast, threshold adjustment is significant in food products sectors except for bread.

3.2 Estimated Transaction costs

Tables 2A, 2B and 2C report the estimated threshold bands for each SRER for the three country pairs. These bands are interpreted as a measure of transaction costs and thus reflect the degree of market integration.

Evidence of a strong NAFTA effect is found for the US-Mexico SRERs. Transaction costs bands and the heterogeneity of the threshold values are significantly reduced after the introduction of the NAFTA. In the pre-NAFTA period, they range from 7 percent (footwear) to 32 percent (tobacco). By contrast, in the post-NAFTA period, threshold values range from 2 percent (fish products) to 20 percent (medical commodities). At an individual level, in sectors such as nonalcoholic beverages, clothing, furniture and medication, transaction costs go from "very large" (unit root process) in the pre-NAFTA period to measurable with a threshold model in the post-NAFTA period. In sectors that exhibit significant nonlinear behavior in both periods, threshold bands are significantly smaller in the post-NAFTA period for meat, dairy, vegetables, tobacco, female clothing and photo equipment. The reduction in the transaction costs bands suggests a greater market integration.

Considering those sectors in which nonlinearities are detected, average transaction costs in the US-Mexico pair are smaller than those for the Mexico-Canada pair. Moreover, for the latter, evidence of unit root behavior is found for a high proportion of sectors. This means that transaction costs are so high that they are not worth arbitraging.

Transaction costs between the US and Canada are the lowest among the three country pairs examined. Overall, average transaction costs among NAFTA members are 34 percent higher between the US and Mexico than between the US and Canada. This result confirms previous evidence that the US and Canada are the most integrated among NAFTA members.[8] We also find less dispersion in the threshold bands in the pre- and post-NAFTA periods. The fact that the integration between Canada and the US started before the introduction of NAFTA could explain this result.

A further look at sectoral characteristics confirms that highly homogenous sectors such as fish and fruits show relatively low threshold bands. This is a standard result in the literature, reported in studies for other country pairs (see Juvenal and Taylor, 2008). Compared with the work of Juvenal and Taylor (2008), threshold bands among NAFTA members are on average slightly lower than those between the United States and European countries.

3.3 Half-Lives of Relative Price Adjustment

A usual measure of the speed of mean reversion is the half-life, which is the time it takes for the effect of 50 percent of a shock to die out. Tables 3A, 3B, and 3C report the estimated half-lives (in terms of months) of price deviations from the LOOP, for the Mexico-US, the Canada-U.S. and the Mexico-Canada SRERs.[9]

The speed of mean reversion is generally computed taking into account the adjustment in the outer regime, which depends on the value of ρ. In this case, the half-life is calculated as if it were a linear model, that is, $\ln(0.5)/\ln(\rho)$. Lo and Zivot (2001) emphasize that the uncertainty of whether the computation of half-lives for linear models is applicable for nonlinear models. However, all studies based on a SETAR model generally use this measure (see, for example, Taylor, 2001). As highlighted in Juvenal and Taylor (2008), although the estimated half-lives of the outer regime yield some insights on the speed of mean reversion, this measure is limited because it does not consider the regime switching within the SETAR model.

[8] One possible alternative explanation for finding that thresholds are lower between the US and Canada than between Mexico and the US may be that goods are more homogenous between the first two countries. More generally, the comparability of the sectors may vary across country pairs. First, wealth effects may be at play. The relatively large income differences between Mexico and the US and Canada affects the specific goods sampled in each CPI category. This disparity may complicate the analysis with the composition between luxury, middle, and ordinary products varying across countries. Second, statistical differences exist in the compilation of price-level data, notably in adjustments for quality changes. A solution to this problem is to look at more disaggregated price indices and SRERs.

[9] We compute the half-lives only for cases in which we find evidence of threshold behavior.

Thus, we compute the half-life using generalized impulse response functions proposed by Koop et al. (1996). This method considers the nonlinear nature of the SETAR model and the different speeds of adjustment in the inner and outer regimes. The SETAR model exhibits an infinite half-life within the threshold band and depends on ρ outside the band. A shock may cause the model to switch regimes, and this adjustment is not captured by the first methodology.

Following Taylor et al. (2001), we compute the impulse response functions conditional on average initial history using Monte Carlo integration for shocks of 10, 20, 30, 40, and 50 percent.[10]

For the Mexico-US pair, the average relative price adjustment is significantly faster in the post-NAFTA period. For example, for a 10 percent shock, the average pre-NAFTA half-life is 20 months, whereas the average is reduced to 11 months in the post-NAFTA period. Our results also yield additional observations. In the post-NAFTA period, there is less variation in the speed of mean reversion across different shock sizes than in the pre-NAFTA period. This suggests that relative prices adjust more quickly, independently of the size of the price shock. Half-lives vary substantially across sectors. Relative prices adjust relatively quickly for homogeneous goods, such as food products. The relative price of the more high-end products (e.g. furniture, and photographic equipment) takes longer to adjust.

The speed of relative price adjustment in the post-NAFTA period is comparable for the Mexico-US and the Canada-US pairs. For a 10 percent shock, the average half-lives are 11 months and 12 months, respectively. This contrasts with significant differences in the pre-NAFTA period when Mexico-U.S. relative prices were much slower to adjust than Canada-U.S. prices. The half-lives of the Mexico-Canada country pairs are also less persistent in the post-NAFTA period.

3.4 Determinants of Thresholds

Based on the estimates of the SETAR models, we determine whether transaction costs are related to economic variables. To do this, we estimate a regression explaining the threshold parameter obtained in section 3.2.

[10] For a complete explanation of generalized impulse responses, see Koop et al. (1996). A method similar to the one used here but applied to an ESTAR model is presented and discussed in detail in Taylor et al. (2001). Clarida and Taylor (2003) show how these methods may be applied to permanent-temporary decompositions within a nonlinear framework.

$$\kappa = \lambda_j^i + \sum_{c=1}^{C} \Phi_j^i(c) z_j^i(c) + \varepsilon_j^i, \tag{17}$$

where κ is the threshold parameter and z_j^i is a vector of explanatory variables. In equation (17) we assess whether transaction costs, measured by the estimated thresholds, are explained by selected explanatory variables.

The explanatory variables are intended to capture the size and nature of transaction costs. The first variable we include is related to distance, which is a proxy for shipping costs. Given the small number of country pairs and their relative proximity, distance appears to be a poor measure. Instead, we include a dummy variable that takes value 1 when countries share a common border. The second variable is the volatility of the nominal exchange rate, which intends to capture the uncertainty about the macroeconomic environment. It is measured as the standard deviation of monthly exchange rate observations. Third, we include a measure of "tradability," defined as the sum of imports and exports to the total output in a sector for a given country sourced from the UNIDO database. Fourth, we use the number of establishments in each sector as a proxy for competition, or concentration, obtained from the UNIDO database. Finally, a dummy for the post-NAFTA period is included.

We examine the determinants of thresholds for the entire sample, including all three country pairs.[11] [12] The results, shown in Table 4, indicate that three variables are significant to explain the size of the estimated thresholds: the post-NAFTA dummy, the border, and nominal exchange rate volatility. These variables are significant in all specifications. We find that the thresholds are lower when countries share a border. Nominal exchange rate volatility is also significant. This indicates that uncertainty about the macroeconomic environment limits arbitrage. The post-NAFTA dummy is also highly significant; the negative coefficient indicates that the introduction of NAFTA is associated with lower transaction costs. Neither the number of firms in a sector nor the degree of "tradability" in a sector are found to be statistically significant (column 1 in Table 4).[13] In column 2, these two variables are excluded with little change in the results.

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[11] Because we cannot obtain data on firms and tradability disaggregated for clothing (women) and clothing (men) but for only a generic clothing sector, we consider the average threshold value of clothing (women) and clothing (men) as the $\widehat{\kappa}$ value for clothing.

[12] In cases in which we find evidence of unit root in deviations from the LOOP, we consider κ to be the highest value of the threshold variable in the grid search. This implies that transaction costs are so high that the entire SRER series is within the threshold band.

[13] The poor quality of the data is a probable explanation for the lack of significance.

Overall, thresholds appear to be determined by distance (border) and exchange rate volatility. These results are in line with findings in the literature. For example, Imbs et al. (2003) find that distance, and exchange rate volatility explain the threshold values.

Another strand of the literature analyzed the determinants of relative price differentials between the US and Canada using different type of models. Our results are consistent with the findings of these studies. As an example, Engel and Rogers (1996) study the nature of deviations from the LOOP using CPI data for 14 goods sectors for different US and Canadian cities. This study shows that the Canadian and US markets are not perfectly integrated and that distance and border are major determinants of price differences. In a related study, Engel et al. (2005) investigate the LOOP between US and Canadian cities using actual prices (instead of price indices). They find that absolute price differences between US and Canadian prices are higher than 7 percent. In addition, their results show that distance and border play a significant role in explaining price differentials between cities.

4 Robustness of Results

We conduct three robustness checks to gauge the sensitivity of empirical results to underlying assumptions and variable definitions. First, we consider the possibility of long-run trends in the measured price differentials arising from aggregation issues in price indices or from the presence of nontradable components or quality differences. We define q^i_{jt} to be the detrended and demeaned component of the price difference x^i_{jt}, given by $x^i_{jt} = c^i_j + \theta t + q^i_{jt}$. As described previously, it is estimated as an OLS residual.

Overall, our baseline findings prove robust to using detrended SRER instead of the demeaned series. Tables 5A, 5B and 5C show the results of the estimation of the SETAR model with detrended sectoral real exchange rates. The conceptual problem with including a trend in the real exchange rate is that it implies that the real exchange rate converges to a different mean across time. This is somewhat contradictory to the LOOP. Hence, our preferred measure is the demeaned series. The stability of our results with the different measures indicates that the trend component may not be of the utmost importance.

Second, we test the sensitivity of the results to a structural break in the Mexican series over the study period (1980 – 2006) during the Tequila crisis. The results reported in the paper assume a constant mean over the period, consistent with the LOOP hypothesis. However, as a robustness check, we also test the sensitivity of the results to (i) allowing for a different mean over the Tequila crisis (1994:12 to 1995:12), and (ii) restricting the estimation period to 1996–2006. This was intended to assess whether the Tequila crisis would significantly affect our findings. Our baseline findings are again robust to these checks. Tables 6A, 6B and 6C report the estimated thresholds for each SRER, allowing for a different mean for the real exchange rate during the Tequila crisis. Across sectors, homogeneous goods have lower transaction costs than other goods in the sample. Across country pairs, average transaction costs among NAFTA members are 27 percent higher between the US and Mexico than between the US and Canada, slightly less than in the results without taking into account the Tequila crisis. The results of the latter robustness analysis (not reported here but available upon request) are broadly consistent with the ones discussed here, which reflects that Tequila crisis does not significantly affect our findings.

5 Summary of Results and Conclusion

Using a SETAR model, we find strong evidence of nonlinearities in SRER dynamics across Mexico, Canada, and the US in the pre-NAFTA and post-NAFTA periods. This result is consistent with the predictions of theoretical models that incorporate some form of market segmentation. Overall, mean reversion occurs when deviations from the LOOP are significant and the benefits to arbitrage are higher than transaction costs.

We obtain two key parameters from the estimation of SETAR models. The first parameter is the threshold, which is a measure of transaction costs. The second parameter is the autoregressive parameter in the outer regime, which determines the speed of mean reversion. We obtain these parameters for each SRER corresponding to the three country pairs for both periods.

Our findings indicate that the value of transaction costs is highly heterogeneous for different sectors and countries. The estimated price thresholds range from 2 percent to 32 percent for the Mexico-US and Canada-US country pairs. The results generally confirm that highly homogeneous sectors, such as fish and fruits, show low threshold bands. Overall, average transaction costs among NAFTA members are 34 percent higher between the US and Mexico than between the US and Canada. This indicates that Mexico and the US are relatively less integrated than Canada and the US. In turn, threshold bands are higher for the Mexico-Canada pair.

We relate the value of the threshold band to plausible economic determinants. Our results show that the border effect and exchange rate volatility are significant determinants of transaction costs. The dummy post-NAFTA is also strongly significant and negative, confirming that the introduction of NAFTA is associated with lower transaction costs.

To shed some light on the mean-reverting properties of the SRERs we consider the regime switching that occurs within and outside the band in the SETAR model and compute the half-lives using generalized impulse response functions. Overall, the speed of mean reversion depends on the size of the shock: larger shocks mean-revert much faster than smaller ones. On average, the half-lives were substantially reduced after the introduction of NAFTA. In the Mexico-US country pair, the average half-life is reduced from 20 months in the pre-NAFTA period to 11 months in the post-NAFTA period. The post-NAFTA period shows less variation in the speed of mean reversion across different shock sizes than in the pre-NAFTA period.

Our analysis therefore supports the arguments that (i) emerging markets –in this case, Mexico– still face higher transaction costs than their developed counterparts, and (ii) trade liberalization may help in lowering relative price differentials between countries. We suspect that lack of competition may be a major determinant of high price thresholds but cannot prove this matter empirically.

The main conclusion of our analysis is that Mexico has made progress but still has considerable room for improvement in reducing barriers to goods market integration and achieving full benefits of globalization. It would be important to further analyze why transactions costs between Mexico and the US continue to exceed those between Canada and the US for many types of goods, and to determine whether these costs can be reduced through policy actions. Examples of such actions include developing logistics, transportation, and internal distribution mechanisms or enhancing the state of competition among domestic firms and reducing remaining barriers to external trade.

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Table 1. Categories of Goods in the CPIs

Sector	Mexico	US	Canada
Bread	Bread, tortillas, and cereals	Cereals and bakery products	Bakery and other cereal products
Meat	Meat	Meat	Meat
Fish	Fish and seafood	Fish and seafood	Fish and other seafood
Dairy	Milk, dairy products, and eggs	Dairy and related products	Dairy products and eggs
Fruits	Fresh fruits	Fresh fruits	Fruit, fruit preparation, and nuts
Veg	Fresh vegetables	Fresh vegetables	Fresh vegetables
Nonalco	Sugar, coffee, and packaged refreshments	Nonalcoholic beverages	–
Alco	Alcoholic beverages	Alcoholic beverages	Alcoholic beverages
Tobac	Tobacco	Tobacco	Tobacco products and smokers' supplies
Clothw	Women's clothing	Women's apparel	Women's wear
Clothm	Men's clothing	Men's apparel	Men's wear
Foot	Footwear	Footwear	Footwear
Fuel	Electricity and fuel	Fuel and utilities	Water, fuel and electricity
Furniture	Furniture	Furniture and bedding	Furniture
Medic	Medications and equipment	Medical care commodities	–
Vehicles	Acquisition of vehicles	New vehicles	Purchase of automotive vehicles
Gasoline	Gasoline and lubricants' oil	Gasoline (all types)	Gasoline
Photo	Photographic equipment and material	Photographic equipment and supplies	–

Table 2A. SETAR Estimation Results: Mexico-US

Sector	Pre-NAFTA				Post-NAFTA				
	Threshold	Outer regime	Unit root test	Hansen test	Threshold	Outer regime	Unit root test	Hansen test	
	κ	ρ	*p-value* H_0^A	*p-value* H_0^B	κ	ρ	*p-value* H_0^A	*p-value* H_0^B	*p-value* H_0^C
Bread	–	–	0.52	–	–	–	0.24	–	–
Meat	0.27	0.92	–	0.00	0.09	0.96	–	0.00	0.00
Fish	–	–	0.15	–	0.02	0.96	–	0.00	–
Dairy	0.28	0.85	–	–	0.10	0.75	–	0.00	0.00
Fruits	–	–	0.25	–	0.05	0.84	–	0.00	–
Veg	0.09	0.78	–	0.00	0.15	0.70	–	0.00	0.05
Nonalco	–	–	0.35	–	0.15	0.81	–	0.00	–
Alco	0.10	0.92	–	0.00	–	–	0.11	–	–
Tobac	0.32	0.73	–	0.00	0.14	0.86	–	0.00	0.00
Clothw	0.18	0.86	–	0.00	0.09	0.83	–	0.00	0.01
Clothm	–	–	0.13	–	0.16	0.87	–	0.00	–
Foot	0.07	0.95	–	0.02	0.08	0.87	–	0.00	0.64
Fuel	–	–	0.34	–	–	-	0.59	–	–
Furniture	–	–	0.28	–	0.18	0.86	–	0.01	–
Medic	–	–	0.14	–	0.20	0.85	–	0.00	–
Vehicles	0.14	0.75	–	0.00	0.12	0.64	–	0.00	0.39
Gasoline	–	–	0.23	–	–	–	0.11	–	–
Photo	0.19	0.97	–	0.03	0.19	0.85	–	0.00	0.00

Notes: This table shows the results from the estimation of the SETAR (1,2,d) model in equation (8). κ is the value of the threshold and ρ is the outer root of the TAR process. The estimation of κ, ρ and d is done simultaneously via a grid search over κ and d as described in Section 2. p-value H_0^A, p-value H_0^B and p-value H_0^C represent, respectively, the marginal significance levels of the null hypothesis of unit root in the outer regime, null hypothesis of linearity, and null hypothesis of equality of thresholds during pre- and post-NAFTA periods.

Table 2B. SETAR Estimation Results: Canada-US

Sector	Pre-NAFTA				Post-NAFTA				
	Threshold	Outer regime	Unit root test	Hansen test	Threshold	Outer regime	Unit root test	Hansen test	
	κ	ρ	*p-value* H_0^A	*p-value* H_0^B	κ	ρ	*p-value* H_0^A	*p-value* H_0^B	*p-value* H_0^C
Bread	–	–	0.36	–	0.09	0.93	–	0.00	–
Meat	0.06	0.91	–	0.00	0.04	0.94	–	0.00	0.39
Fish	0.08	0.85	–	0.00	0.04	0.90	–	0.00	0.08
Dairy	0.07	0.91	–	0.00	0.07	0.95	–	0.00	–
Fruits	0.16	0.95	–	0.02	0.09	0.79	–	0.00	–
Veg	0.14	0.80	–	0.00	0.05	0.79	–	0.00	0.01
Alco	0.15	0.89	–	0.00	0.14	0.93	–	0.00	0.47
Tobac	–	–	0.14	–	–	–	0.41	–	–
Clothw	0.05	0.94	–	0.00	0.13	0.81	–	0.00	0.07
Clothm	–	–	0.23	–	0.14	0.93	–	0.00	–
Foot	–	–	0.18	–	0.08	0.96	–	0.00	–
Fuel	0.08	0.95	–	0.00	0.04	0.94	–	0.00	0.07
Furniture	0.16	0.91	–	0.00	0.10	0.95	–	0.00	0.02
Vehicles	0.08	0.92	–	0.00	0.07	0.94	–	0.00	0.54
Gasoline	0.27	0.79	–	0.00	0.28	0.72	–	0.00	0.46

Notes: See Table 2A.

Table 2C. SETAR Estimation Results: Mexico-Canada

Sector	Pre-NAFTA				Post-NAFTA				
	Threshold	Outer regime	Unit root test	Hansen test	Threshold	Outer regime	Unit root test	Hansen test	
	κ	ρ	*p-value* H_0^A	*p-value* H_0^B	κ	ρ	*p-value* H_0^A	*p-value* H_0^B	*p-value* H_0^C
Bread	–	–	0.34	–	–	–	0.53	–	–
Meat	0.24	0.90	–	0.00	0.76	–	–	0.00	0.03
Fish	0.14	0.87	–	0.0	0.14	–	–	0.01	–
Dairy	0.30	0.80	–	0.00	0.19	–	–	0.00	0.00
Fruits	–	–	0.17	–	0.15	–	–	0.00	–
Veg	0.15	0.71	–	0.0	0.21	–	–	0.00	0.07
Alco	0.23	0.92	–	0.00	0.27	–	–	0.00	0.58
Tobac	–	–	0.14	–	–	–	0.25	–	–
Clothw	0.15	0.8	–	0.00	0.21	–	–	0.00	0.14
Clothm	0.17	0.90	–	0.00	0.20	–	–	0.00	0.19
Foot	0.10	0.90	–	0.00	0.20	–	–	0.00	0.03
Fuel	–	–	0.27	–	–	–	0.61	–	–
Furniture	–	–	0.16	–	0.22	–	–	0.00	0.01
Vehicles	–	–	0.18	–	–	–	0.66	–	–
Gasoline	–	–	0.13	–	–	–	0.24	–	–

Notes: See Table 2.A.

Table 3A. Half-Lives: Mexico-US

Sector	Pre-NAFTA Shock (%) 10	20	30	40	50	Post-NAFTA Shock (%) 10	20	30	40	50
Bread	–	–	–	–	–	–	–	–	–	–
Meat	36	26	20	17	15	29	25	23	22	21
Fish	–	–	–	–	–	19	18	18	18	18
Dairy	20	15	11	9	8	7	5	5	5	5
Fruits	–	–	–	–	–	6	5	5	5	5
Veg	4	4	4	4	4	5	5	5	5	5
Nonalco	–	–	–	–	–	7	7	6	6	6
Alco	13	12	12	11	11	–	–	–	–	–
Tobac	18	12	8	7	6	8	7	7	7	7
Clothw	10	10	10	9	9	5	5	5	5	5
Clothm	–	–	–	–	–	10	8	8	7	7
Foot	18	17	16	16	16	6	6	6	6	6
Fuel	–	–	–	–	–	–	–	–	–	–
Furniture	–	–	–	–	–	14	10	8	8	8
Medic	–	–	–	–	–	8	8	8	8	7
Vehicles	6	5	5	4	3	6	4	4	4	4
Gasoline	–	–	–	–	–	–	–	–	–	–
Photo	55	49	44	40	37	24	14	10	9	8
Average	20	17	14	13	12	11	9	8	8	8

Notes: This table shows the estimated half-lives of deviations from the LOOP for five sizes of percentage shock: 10, 20, 30, 40 and 50. The half-lives were calculated conditional on average initial history using the generalized impulse response functions procedure developed by Koop et al. (1996).

Table 3B. Half-Lives: Canada-US

Sector	Pre-NAFTA Shock (%)					Post-NAFTA Shock (%)				
	10	20	30	40	50	10	20	30	40	50
Bread	–	–	–	–	–	14	12	12	11	11
Meat	11	10	10	10	9	13	12	12	12	12
Fish	6	5	4	4	4	9	8	8	8	8
Dairy	12	10	10	10	10	16	15	15	14	14
Fruits	27	24	21	20	19	5	5	5	5	5
Veg	7	6	6	6	6	5	5	5	5	5
Alco	13	10	9	9	9	17	16	15	14	13
Tobac	–	–	–	–	–	–	–	–	–	–
Clothw	14	13	12	12	11	7	7	6	6	6
Clothm	–	–	–	–	–	18	15	14	13	13
Foot	–	–	–	–	–	25	22	20	20	19
Fuel	17	15	15	15	15	12	12	12	12	11
Furniture	21	15	13	12	12	29	24	21	19	18
Vehicles	13	12	11	11	11	14	13	13	13	12
Gasoline	8	7	6	6	6	7	5	5	5	5
Average	14	12	11	10	10	12	11	11	10	10

Notes: See Table 3A.

Table 3C. Half-Lives: Mexico-Canada

Sector	Pre-NAFTA Shock (%)					Post-NAFTA Shock (%)				
	10	20	30	40	50	10	20	30	40	50
Bread	–	–	–	–	–	–	–	–	–	–
Meat	24	17	13	12	11	7	6	6	6	6
Fish	10	8	7	7	6	16	14	12	12	12
Dairy	9	7	6	5	5	11	9	9	8	8
Fruits	–	–	–	–	–	5	4	4	4	4
Veg	4	4	4	4	4	5	4	4	4	4
Alco	16	14	13	12	11	16	15	14	14	14
Tobac	–	–	–	–	–	–	–	–	–	–
Clothw	10	10	9	8	8	11	10	9	8	8
Clothm	12	11	11	10	9	14	13	12	12	11
Foot	9	8	8	8	7	15	13	12	12	11
Fuel	–	–	–	–	–	–	–	–	–	–
Furniture	–	–	–	–	–	8	6	6	5	5
Vehicles	–	–	–	–	–	–	–	–	–	–
Gasoline	–	–	–	–	–	–	–	–	–	–
Average	12	10	9	8	8	11	10	9	9	9

Notes: See Table 3A.

Table 4. Threshold Regressions

	(1)	(2)
Distance	-0.042 (0.054)*	-0.036 (0.058)*
Dummy post-NAFTA	-0.105 (0.002)**	-0.111 (0.001)**
Exchange Rate volatility	4.468 (0.000)***	4.266 (0.000)***
Firms	-0.002 (0.477)	
Tradeability	-0.045 (0.259)	
R^2	0.34	0.33
N	89	89

Notes: This table shows the results from the estimation of equation (17). In parenthesis are the $p-values$. *, ** and *** denote significance at the 10 percent, 5 percent and 1 percent levels, respectively.

Table 5A. SETAR Estimation Results (Detrended Data): Mexico-US

Sector	Pre-NAFTA				Post-NAFTA			
	Threshold	Outer regime	Unit root test	Hansen test	Threshold	Outer regime	Unit root test	Hansen test
	κ	ρ	*p-value* H_0^A	*p-value* H_0^B	κ	ρ	*p-value* H_0^A	*p-value* H_0^B
Bread	–	–	0.31	–	–	–	0.14	–
Meat	0.26	0.92	–	0.00	0.03	0.94	–	0.00
Fish	–	–	0.18	–	0.03	0.95	–	0.00
Dairy	0.29	0.84	–	–	0.09	0.83	–	0.00
Fruits	–	-	0.13	–	0.02	0.82	–	0.00
Veg	0.06	0.77	–	0.00	0.15	0.78	–	0.00
Nonalco	–	–	0.16	–	0.10	0.76	–	0.00
Alco	0.22	0.79	–	0.00	–	–	0.17	–
Tobac	–	–	0.15	0.00	0.16	0.90	–	0.00
Clothw	0.17	0.88	–	0.00	0.18	0.80	–	0.00
Clothm	–	–	0.33	–	0.15	0.77	–	0.00
Foot	0.11	0.93	–	0.02	0.09	0.88	–	0.00
Fuel	–	–	0.22	–	–	–	0.70	–
Furniture	–	–	0.46	–	0.16	0.81	–	0.01
Medic	–	–	0.27	–	0.15	0.88	–	0.00
Vehicles	0.16	0.79	–	0.00	0.09	0.70	–	0.00
Gasoline	–	–	0.19	–	–	–	0.17	–
Photo	0.16	0.96	–	0.02	0.17	0.90	–	0.00

Notes: See Table 2A.

Table 5B. SETAR Estimation Results (Detrended Data): Canada-US

Sector	Pre-NAFTA				Post-NAFTA			
	Threshold	Outer regime	Unit root test	Hansen test	Threshold	Outer regime	Unit root test	Hansen test
	κ	ρ	*p-value* H_0^A	*p-value* H_0^B	κ	ρ	*p-value* H_0^A	*p-value* H_0^B
Bread	–	–	0.40	–	0.15	0.83	–	0.00
Meat	–	–	0.23	–	0.03	0.95	–	0.00
Fish	0.11	0.85	–	0.00	0.02	0.94	–	0.00
Dairy	0.05	0.94	–	0.00	0.07	0.92	–	0.00
Fruits	0.11	0.88	–	0.02	0.09	0.83	–	0.00
Veg	0.04	0.72	–	0.00	0.03	0.85	–	0.00
Alco	0.08	0.91	–	0.00	0.10	0.82	–	0.00
Tobac	–	–	0.22	–	–	–	0.22	–
Clothw	0.04	0.90	–	0.00	0.09	0.80	–	0.00
Clothm	0.06	0.88	–	0.00	0.11	0.94	–	0.00
Foot	–	–	0.12	–	0.05	0.90	–	0.00
Fuel	0.05	0.90	–	0.00	0.09	0.86	–	0.00
Furniture	0.08	0.87	–	0.00	0.16	0.91	–	0.00
Vehicles	0.09	0.80	–	0.00	0.10	0.95	–	0.00
Gasoline	0.16	0.97	–	0.00	0.05	0.80	–	0.00

Notes: See Table 2A.

Table 5C. SETAR Estimation Results (Detrended Data): Mexico-Canada

Sector	Pre-NAFTA				Post-NAFTA			
	Threshold	Outer regime	Unit root test	Hansen test	Threshold	Outer regime	Unit root test	Hansen test
	κ	ρ	*p-value* H_0^A	*p-value* H_0^B	κ	ρ	*p-value* H_0^A	*p-value* H_0^B
Bread	0.28	0.82	–	0.00	0.21	0.72	–	0.00
Meat	0.22	0.92	–	0.00	0.11	0.88	–	0.00
Fish	–	–	0.13	–	0.12	0.92	–	0.00
Dairy	0.31	0.91	–	0.00	0.20	0.87	–	0.00
Fruits	–	–	0.11	–	0.08	0.78	–	0.00
Veg	0.08	0.75	–	0.00	0.12	0.70	–	0.00
Alco	0.22	0.83	–	0.00	0.25	0.93	–	0.01
Tobac	–	–	0.19	–	–	–	0.55	–
Clothw	0.24	0.94	–	0.02	0.24	0.72	–	0.00
Clothm	0.23	0.93	–	0.01	0.24	0.82	–	0.00
Foot	0.15	0.85	–	0.00	0.20	0.92	–	0.00
Fuel	–	–	0.35	–	–	–	0.31	–
Furniture	–	–	0.19	–	0.18	0.86	–	0.00
Vehicles	–	–	0.17	–	–	–	0.15	–
Gasoline	–	–	0.18	–	–	–	0.39	–

Notes: See Table 2A.

Table 6A. SETAR Estimation Results (Different Mean during Tequila Crisis): Mexico-US

Sector	Post-NAFTA			
	Threshold	Outer regime	Unit root test	Hansen test
	κ	ρ	*p-value* H_0^A	*p-value* H_0^B
Bread	–	–	0.54	–
Meat	0.14	0.82	–	0.00
Fish	0.13	0.91	–	0.00
Dairy	0.07	0.71	–	0.00
Fruits	0.05	0.77	–	0.00
Veg	0.04	0.83	–	0.00
Nonalco	0.14	0.78	–	0.00
Alco	0.11	0.93	–	0.00
Tobac	0.08	0.89	–	0.00
Clothw	0.09	0.83	–	0.00
Clothm	0.10	0.79	–	0.00
Foot	0.08	0.94	–	0.00
Fuel	0.14	0.75	–	0.00
Furniture	0.11	0.90	–	0.00
Medic	0.17	0.77	–	0.00
Vehicles	0.12	0.83	–	0.00
Gasoline	–	–	0.25	–
Photo	0.12	0.91	–	0.00

Notes: See Table 2A.

Table 6B. SETAR Estimation Results (Different Mean during Tequila Crisis): Canada-US

Sector	Post-NAFTA		
	Threshold	Outer Regime	Hansen Test
	κ	ρ	$p\text{-}value\ H_0^B$
Bread	0.09	0.93	0.00
Meat	0.04	0.94	0.00
Fish	0.04	0.90	0.00
Dairy	0.07	0.95	0.00
Fruits	0.09	0.79	0.00
Veg	0.05	0.79	0.00
Alco	0.14	0.93	0.00
Tobac	0.05	0.95	0.03
Clothw	0.13	0.81	0.00
Clothm	0.14	0.93	0.00
Foot	0.08	0.96	0.00
Fuel	0.04	0.94	0.00
Furniture	0.10	0.95	0.00
Vehicles	0.07	0.94	0.00
Gasoline	0.26	0.72	0.00

Notes: See Table 2A

Table 6C. SETAR Estimation Results (Different Mean during Tequila Crisis): Mexico-Canada

	Post-NAFTA			
Sector	Threshold	Outer Regime	Unit Root Test	Hansen Test
	κ	ρ	*p-value* H_0^A	*p-value* H_0^B
Bread	–	–	0.74	–
Meat	0.20	0.92	–	0.00
Fish	0.13	0.91	–	0.00
Dairy	0.08	0.97	–	0.05
Fruits	0.08	0.83	–	0.00
Veg	0.04	0.80	–	0.00
Alco	0.06	0.95	–	0.02
Tobac	–	–	0.25	–
Clothing	0.10	0.90	–	0.00
Clothm	0.11	0.89	–	0.00
Foot	0.06	0.95	–	0.02
Fuel	0.14	0.77	–	0.01
Furniture	–	–	0.16	–
Vehicles	–	–	0.13	–
Gasoline	–	–	0.07	–

Notes: See Table 2A.