

## BORDER EFFECTS BETWEEN U.S. AND MEXICO

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I use disaggregated good prices data for U.S. and Mexican cities for nine categories of consumer prices to estimate the “border effect” on U.S. - Mexican relative price and find that for all the categories of goods it is an order of magnitude larger than for U.S. - Canadian prices (13.22 versus 2.25 for the CPI) However, during a very stable period in Mexico (May 1988 to November 1994), the “width” of the border falls dramatically for all the categories of goods analyzed (3.22 versus 13.22 for the CPI).

*Keywords:* Exchange Rates, Disaggregated Good Prices, Border Effect

*JEL classification:* F30, F40, F41

### 1. INTRODUCTION

Against a backdrop of macroeconomic instability and inequitable income distribution, in the mid-1980s Mexico adopted an aggressive liberalization strategy that has closely integrated its economy to the global market, and that of the United States in particular, especially after entering the North American Free Trade Agreement (NAFTA) in 1994. As a result, both trade and investment flows increased substantially throughout the 1990s and the share of employment linked to the world economy rose considerably.

NAFTA consolidated the liberalization of the Mexican economy and opened up the Canadian and U.S. markets to Mexican producers. The immediate result of the rapid dismantling of trade barriers has been a remarkable increase in Mexico’s world trade. From 1990 to 2000, total imports and exports increased more than fourfold, reaching U.S. \$174 and U.S. \$166 billion, respectively. While the share of imports coming from North America has remained constant at around 75 percent, Mexico’s exports to the region went from 80 to 91 percent of all exports from 1990 to 2000. As a result, Mexican producers now face fiercer competition in their home market and send a greater fraction of their output overseas.

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Just as Mexico became more open to trade flows, the country revamped its legal framework regulating foreign investment, substantially opening the Mexican economy as a whole to foreign investors. Whereas FDI remained below one percent of GDP over the 1970-1985 period, it rose to between one and two percent from 1986 to 1993, and it has remained above two percent since 1994.

However, current research has revealed that consumer prices are not nearly as equalized across countries as one would anticipate in a highly integrated region. The empirical studies find large departures from the law of one price.

In particular, Engel and Rogers (1996) analyze the variability of the relative prices of similar goods, using consumer price data from 23 cities in U.S. and Canada. They concluded that relative price variability is positive and significantly related to distance between cities. However, taking into account the effect of distance, relative price variability is remarkably larger for cities that lie across an international border than for cities that lie within either country. Engel and Rogers (1996) name this the “width of the border”.

There are several possible explanations for this large border effect in prices. These include barriers to international trade, such as tariffs, quotas, and non-tariff barriers such as bureaucratic red tape imposed on foreign business, the presence of non-tradable goods and services, labor markets that are more integrated and homogenous within countries than they are across countries, and distributions networks. An alternative explanation relies on nominal exchange rate variability with sticky final goods prices in local currency. When the nominal exchange rate fluctuates so do relative goods price for cross border cities pairs.

Rogers and Smith (2001) apply the Engle and Rogers (1996) methodology to quantify the U.S. - Mexican border. They show that the border effect between U.S. and Mexico prices is larger than that for the U.S. and Canadian prices. Therefore, there is a relatively larger border effect on U.S. - Mexican prices. However, they use aggregate price data.

In a related work, Engel, Rogers and Wang (2003) use actual price data to quantify a larger border effect between U.S. and Canada. They use very disaggregated data from the Economist Intelligence Unit. The main drawback is that there is a large degree of measurement error in these unofficial prices.

Because I want to analyze the nature of deviations from the law of one price and the U.S. and Mexican consumer price indexes are constructed somewhat differently<sup>1</sup> and the basket weights are not the same in any event, I will study deviations from the law of one price for similar categories of goods and not for the general CPI.

The main contribution of this paper is to extend Rogers and Smith (2001) using disaggregated official consumer price indexes (and with less measurement error) from cities

<sup>1</sup> The comparisons of CPI indexes between countries raise the following problems: how to handle the introduction of new goods, shifting consumption weights within a country, etc.

in U.S. and Mexico. In this paper I use consumer prices indexes for several goods from Mexican and U.S. cities to estimate border effects on relative price between Mexico and U.S. Also, I analyze the border during the subperiod May 1988 to November 1994 known as El Pacto Period. During this period the peso-USD exchange rate was quite stable.

## 2. DATA

I use consumer price data for 14 cities in USA and 14 cities in Mexico for disaggregated consumer price indexes. The data cover the period from January 1984 to December 1997. The sample ends in 1997 because the U.S. Bureau of Labor Statistics changed the Consumer Price Index base in 1998.

Table 1 lists the good in the study. Given that the data is very important to understand the contents of this paper I explain it in detail.

**Table 1.** Categories of Good in Disaggregated Consumer Price Indexes Used

Good	United States	Mexico
1	Food at Home	Food purchased from stores
2	Food away from home	Restaurants and cafeterias
3	Footwear	Footwear
4	Shelter	Shelter
5	Fuel and other utilities	Electricity and fuel
6	Household furnishings and operations	Furniture and home equipment
7	Medical care	Medical care
8	Public Transportation	Public Transportation
9	Private Transportation	Transportation by your own

The data from Mexico was obtained from the Bank of Mexico ([www.banxico.org.mx](http://www.banxico.org.mx)). The data from USA was obtained from the Bureau of Labor Statistics ([stats.bls.gov](http://stats.bls.gov)) All of the price data for both countries are seasonally unadjusted.

The data for the exchange rate was obtained also from the Bank of Mexico.

The distance in miles between cities was download from [www.expedia.com](http://www.expedia.com), I work with the shortest driving distance between cities.

The 14 Mexican cities are Acapulco, Chihuahua, Guadalajara, Hermosillo, Juarez, Matamoros, Merida, Mexicali, México Distrito Federal, Monterrey, Tampico, Tijuana, Veracruz, Villahermosa. For all of these cities the price data are monthly.

Monthly price data for U.S. are available only for four “core” cities: New York, Philadelphia, Chicago and Los Angeles. In addition for five cities, data are released in odd numbered month: Boston, Miami, St. Louis, Washington DC and Baltimore. For

five other cities data are available in even numbered months: Dallas, Houston, Pittsburgh, Detroit and San Francisco.

For each good  $i$  I calculate the log of the intercity  $(j, k)$  relative price, that is  $\text{Log}[CPI_t^i(j)/CPI_t^i(k)]$ , where  $t$  denotes time. Because I apply this formula, I only calculate the relative prices for cities that report the CPI in the same time  $t$ . In order to calculate the volatility of changes in prices I compute the standard deviation of the 6-month changes in the log of the relative price (Standard Deviation of  $\text{Log}[CPI_{t+6}^i(j)/CPI_{t+6}^i(k)] - \text{Log}[CPI_t^i(j)/CPI_t^i(k)]$ ).

Thus, when I use only the Mexican cities and the core U.S. cities, for each good there are 153 intercity prices ( $18 \cdot 17 / 2$ ). Adding the five even month U.S. cities adds another 100 prices ( $18 \cdot 5 + 5 \cdot 4 / 2$ ), and adding the five odd month U.S. cities adds another 100 prices. The total number of city pairs for each good is 353.

Note that I don't match the U.S. cities whose data is reported even month with those cities that reported data odd month. Also note that I have 91 city pairs for Mexican cities ( $13 \cdot 12 / 2$ ), 66 for U.S. ( $4 \cdot 3 / 2 + 2 \cdot (4 \cdot 5 + 5 \cdot 4 / 2)$ ), and 196 cross border pair cities ( $14 \cdot 14$ ).

## 2.1. Summary Statistics

Table 2 reports summary statistics. For each of the 9 goods and the Consumer Price Index I report the average standard deviation for pairs of cities that are: (a) both in USA, (b) both in Mexico, and (c) one in each country.

Table 2 reveals that the volatility of prices between Mexican cities is higher than that between U.S. cities pairs.<sup>2</sup> The volatility of prices between U.S. cities are 0.0105, close to the estimation of Rogers and Smith (2001) of 0.0097. For the Mexican cities I obtained a volatility of 0.0159, against their estimation of 0.0172. This may indicate that it is more costly to transport goods between Mexican cities than between equi-distant cities within the U.S.. However, cross border cities pairs have much higher volatility. Note that for the CPI the cross border volatility is ten times higher than the volatility between Mexican cities. However for the categories of goods analyzed all cross border volatility ranges only from 1.5 to 5 times the volatility of Mexican cities.

Note for the distance between cities that the inter-national city pairs are on average slightly farther apart than are the intra-national pairs.

<sup>2</sup> The only exception is in the footwear, where the volatility is higher in U.S. pair cities.

**Table 2.** Average Price Volatility 1984 - 1997 for 6 Month Change

Good	City Pairs		
	US US	MX MX	US MX
1	0.0222	0.0283	0.1350
2	0.0190	0.0690	0.1734
3	0.0962	0.0698	0.1929
4	0.0214	0.0670	0.2398
5	0.0494	0.1352	0.1838
6	0.0335	0.0407	0.1627
7	0.0211	0.0735	0.1691
8	0.0744	0.1325	0.1929
9	0.0189	0.0362	0.1525
CPI	0.0105	0.0159	0.1521
Distance(miles)	1242	990	1973

In table 3 I present summary statistics for the volatility of relative prices in El Pacto Period.<sup>3</sup> During that period of stability in the Mexican economy the volatility of prices is lower than for the full period. Also, the volatility of cities pairs across borders is near one third of the volatility between 1984 and 1997.

**Table 3.** Average Price Volatility during El Pacto Period

Good	City pairs		
	US US	MX MX	US MX
1	0.0232	0.0227	0.0553
2	0.0147	0.0475	0.0645
3	0.0965	0.0395	0.0876
4	0.0191	0.0551	0.1146
5	0.0395	0.1181	0.1157
6	0.0319	0.0258	0.0627
7	0.0193	0.0595	0.0696
8	0.0714	0.0925	0.1313
9	0.0188	0.0358	0.0918
CPI	0.0097	0.0114	0.0491

<sup>3</sup> From May 1988 to November 1994.

Table 4 shows that the volatility of the exchange rate drops substantially during El Pacto Period. During this period the volatility of the Mexican inflation decreases substantially, in conjunction with an overall improvement in macroeconomic and financial conditions in Mexico.

**Table 4.** Exchange Rate Volatility for 6 Month Changes

1984:01 - 1997 :12	0.1758
1988:05 - 1994 :11	0.0287

*Note:* The columns display the mean value of the standard deviation of changes in the nominal exchange rate.

### 3. ORDINARY LEAST SQUARES ESTIMATION

Following Engel and Rogers (1996), my regressions attempt to explain the standard deviation of  $\Delta P(j,k)$ . Engel and Rogers (1996) hypothesize that the volatility of the prices of similar goods sold in different locations is related to the distance between the locations and other explanatory variables, including a dummy variable *Border*, for whether the cities are in different countries.

In particular I estimate the following cross-section regression:

$$V(\Delta P^i(j,k)) = \beta_1^i r_{j,k} + \beta_2^i B_{j,k} + \sum \alpha(m) D_m + \varepsilon_{j,k}, \quad (1)$$

where  $r_{j,k}$  is the log of the distance between locations. I expect  $\beta_1$  to be positive, as the variation in transport costs should be larger the greater the distance between locations.<sup>4</sup>

As in the gravity model of trade I expect a positive relationship between relative-price volatility and distance. Countries are more likely to trade with neighbors because the transportation costs are lower.

I also include a dummy variable in the equation for each city in the sample,  $D_m$ . That is, for city pair  $(j,k)$  the dummy variables for city  $j$  and  $k$  take on value of 1. The inclusion of separate dummies for each city allows the standard deviation of prices to vary from city to city. There are a few reasons why I allow the level of standard deviation to vary from city to city. First, there may be idiosyncratic measurement error in some cities that make their prices more volatile on average. Second, there may be differences across methodologies for gathering data. Third, for the cities that report prices only bimonthly, there may be additional volatility that is introduced by measurement errors from the less frequent observation of prices. Fourth, an empirical

<sup>4</sup> Note that distance proxies for more than just transportation costs.

motivation comes from Table 2, which indicates greater relative price volatility for Mexican cities than U.S. cities.

$B_{j,k}$  the border variable, is a dummy variable for whether locations  $j$  and  $k$  are in different countries. I expected the border to be positive, and I am interested in comparing the width of the U.S. - Mexican border to the U.S. - Canadian border estimated in Rogers and Smith (2001).

Table 5 shows the OLS results while considering the standard deviation of the 6-month changes in prices as the dependent variables and the log of the distance between cities and the border variable as independent variables.

**Table 5.** OLS Regressions

Good	Log Distance	Border	Adj. R <sup>2</sup>
1	0.28 (0.27)	10.09 (0.35)	0.89
2	0.11 (0.11)	12.38 (0.26)	0.92
3	1.30 (1.70)	10.40 (0.23)	0.94
4	0.61 (0.34)	18.06 (0.44)	0.92
5	0.62 (0.31)	8.97 (0.39)	0.81
6	0.24 (0.16)	11.95 (0.20)	0.96
7	0.05 (0.18)	11.69 (0.24)	0.95
8	0.06 (0.18)	8.11 (0.24)	0.90
9	0.49 (0.14)	11.84 (0.19)	0.96
CPI	0.24 (0.16)	13.22 (0.20)	0.98

*Notes:* The sample period is 1984:1-1997:12 for the 28 cities. Heteroscedasticity consistent standard errors are in parenthesis (White (1980)). The dependent variable is the standard deviation of the 6-month Changes in the log relative price. The independent variables are: the log of the distance between cities in the particular pair (miles) Border which equals unity if the cities in the pair lie across an international border. The estimation includes 28 cities dummies. Coefficients and standard errors have been multiplied by 100.

The coefficient on the log distance is positive for the 9 goods, but it is significant at the 5% level for only 3 goods.<sup>5</sup>

The coefficient on the dummy variable for the border is of hypothesized sign and highly significant for all 9 goods. The interpretation of the coefficient on the border dummy in this regression is the difference between the average standard deviation of prices for city pairs that lie across the border less the average for pairs that lie within one of the two countries, taking into account the effect of distance.

For the CPI, the coefficient on the dummy Border is 13.22 slightly higher than the value of 9.76 found by Rogers and Smith (2001).

I have confirmed the finding of Rogers and Smith (2001) of a positive large and significant border effect using disaggregated consumer price data. This mean, that the border effect is significant not also for the CPI but for different categories of goods.

It is interesting to explore the cross-sectional evidence in more details. In particular, some of the times (shelter) are nontraded, others (public transportation) are nontraded and perhaps subject to regulation, yet others (footwear) are traded. These features would be expected to provide a useful way of differentiating the cost of arbitrage from the exchange rate volatility explanation. In the Table 5 the larger border effect is observed for tradable and nontradable goods; however distance is in general insignificant in explaining price variability among tradable. Therefore, the evidence suggests that an important part of the larger border effect is explained by nominal exchange rate variability with stick final good prices.

The most remarkable finding in Table 5 is that for all the categories of goods the border effect it is of an order of magnitude larger than for U.S. - Canadian prices.

### **3.1. Sub-Sample: El Pacto Period**

El Pacto Period runs from May 1988 to November 1994. The main feature of this period is the overall improvement in the macroeconomic conditions in Mexico. Trough this period the standard deviation of the peso-USD was similar to the standard deviation of the Canadian Dolar-USD.

During the stable peso period we see that the coefficients on the border dummy are notably smaller than in the entire sample period. For the CPI the dummy variable falls from 13.22 to 3.74. For the CPI, the coefficient on the dummy Border is slightly higher than the value of 2.55 found by Rogers and Smith (2001).

<sup>5</sup> Within countries, the log distance is significant and positive for the goods 1,3,4,5,8,9 and CPI in Mexico, and for the goods 1,3,8,9 in U.S..



**Table 6.** OLS Regressions El Pacto Period

Good	Log Distance	Border	Adj. R <sup>2</sup>
1	-0.08 (0.07)	3.11 (0.11)	0.90
2	-0.05 (0.08)	3.22 (0.12)	0.88
3	0.13 (0.10)	1.66 (0.14)	0.88
4	0.28 (0.18)	7.16 (0.24)	0.85
5	0.51 (0.38)	3.80 (0.47)	0.63
6	-0.01 (0.09)	3.16 (0.13)	0.86
7	-0.03 (0.08)	2.91 (0.10)	0.87
8	0.38 (0.19)	4.20 (0.23)	0.80
9	0.43 (0.15)	5.91 (0.22)	0.81
CPI	-0.03 (0.06)	3.74 (0.09)	0.93

*Notes:* The sample period is 1988:5-1994:11 for the 28 cities. Heteroscedasticity consistent standard errors are in parenthesis White (1980) The dependent variable is the standard deviation of the 6-month change in the log relative price. The independent variables are: the log of the distance between cities in the particular pair (miles), Border which equals unity if the cities in the pair lie across an international border. The estimation includes 28 cities dummies. Coefficients and standard errors have been multiplied by 100.

#### 4. CONCLUSIONS

I use consumer prices indexes for several goods from cities in USA and Mexico, to quantify the extent to which prices fails to equalize across countries against a baseline of the size of the failure across regions within countries. That is, I compute the Enge-Rogers “width of the border” measures for Mexico.

Focus on 6-month changes and over the sample period 1984-1997, I show that the border effect in U.S. - Mexican prices is an order of magnitude larger than that obtained by Engel and Rogers (1996) for U.S. - Canadian. In addition, during El Pacto Period the border decreases dramatically and becomes only slightly higher than the U.S. - Canada border.

The major conclusion of the paper is that the border effects between U.S. and Mexico matter for relative price variability for several categories of similar goods. That is, I extend the Rogers and Smith (2001) result that validate the border effect only considering CPI.

Also the evidence suggests that an important part of the larger border effect is explained by nominal exchange rate variability with stick final good prices.

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