What can we learn from a large border effect in developing countries?

A.K.M. Mahbub Morshed*

Department of Economics, Washington State University, Box 644741, Pullman, WA 99164, USA

Received 1 May 2001; accepted 1 July 2002

Abstract

Failure of the law of one price (LOP) in the short run is an empirical regularity. Recent research, using disaggregated price data for different cities across an international boundary, has shown that the variation of the prices in equidistant cities located in two different countries is systematically larger than that for the cities within the same country. Nontariff barriers and exchange rate variability are cited as the proximate causes of this systematic difference in consumer price variability. Results using data from developing countries with large nontariff barriers and more volatile exchange rate suggest that those claims are overemphasized.

© 2003 Elsevier Science B.V. All rights reserved.

JEL classification: F40; F41

Keywords: Law of one price; Border effect

1. Introduction

The recent research in testing the Purchasing Power Parity (PPP) doctrine using disaggregated price data has improved our understanding about consumer price movement in cities across a border (see Engel and Rogers, 2001a,b; Parsley and Wei 2001). The commonly used methodology in this research program is to devise an empirical test for the core of the PPP theory, the law of one price (LOP). One such test requires comparing consumer price movement at different locations within a country and for locations across a border. If the border does not matter, then we expect that the price variation at locations
within the same country would not be systematically different from the price variation at locations across the border.

Engel and Rogers (1996) have found, using disaggregated time series price data for cities in the USA and Canada, that the variability of relative price is systematically much higher at locations across a border compared to that at equidistant locations either within the USA or within Canada. Therefore, the variability of the relative price between cities like Seattle and Vancouver is much higher than the variability of the relative price between Seattle and Boston or Vancouver and Toronto. This is a very important finding given the fact that trade restrictions between the USA and Canada are not very significant. The observed differences in the variability of relative prices are so large that they have opined that there exists some unexplained “border effect” that adds a significant amount of variability in relative price when goods cross a border.

A version of the LOP implies that the differences in prices of the same commodity at different locations should be equal to the transportation costs due to the realization of no arbitrage condition. However, proponents of pricing-to-market (PTM) theory argue that we should not expect equality of prices at different locations because producers set different prices for different locations (see Dornbusch, 1987; Krugman, 1987; Dixit, 1989; Feenstra, 1989; Froot and Klemperer, 1989; Knetter, 1993). There are at least two arguments in favor of pricing-to-market (PTM). One, profit-maximizing monopolists may accept different markups at different locations, which may vary due to fluctuations in the nominal exchange rates. Two, the retail prices of consumer goods incorporate the prices of nontraded services, and these nontraded services may be highly integrated on a national basis. This segmentation of markets due to presence of a border is assumed to be an important factor for the pricing-to-market (PTM).

Engel and Rogers (1996) postulate two other possible reasons for a border being an important determinant of price variation in cities in different countries. Productivity shocks may be felt in the same way at different locations within a country but not at locations across borders. The other reason is that the price of a consumer good may be sticky in terms of the currency of the country where the good is sold (see Devereaux and Engel, 1998).

In order to examine whether a tariff barrier is responsible for an observed large border effect, it is imperative to estimate the size of the border effect for countries with different tariff regimes. Engel and Rogers (2000) have calculated the border effect for the USA and Canada before and after the North American Free Trade Agreement (NAFTA). Surprisingly, they have found a very large border effect even during the NAFTA period. To take into account nontariff barriers, in another paper for European countries, Engel and Rogers (2001b) have included language in their regression with little success.

Nominal exchange rate variability is also cited as another proximate cause of the large border effect. From a cross-section study of 96 developed and developing countries, Bahmani-Oskooee (1991) has found that nominal exchange rate variability is a contributing factor to inflation variability. Parsley and Wei (2001) have included exchange rate variability as a regressor in the relative price variability equation and have found that exchange rate variability plays a significant role, but still does not completely account for the border effect.
All these studies suggest that nontraded services and nominal exchange rate variability may hold the key to the explanation of a large border effect. In order to evaluate the contribution of nontariff barriers and nominal exchange rate variability in a large border effect, it is important to see what happens to the size of the border effect if we consider two countries with very high nontariff barriers and significantly large nominal exchange rate variability. If we get results similar to these we have got so far, then the importance of these factors in explaining the large border effect is surely overemphasized.

To settle this issue more rigorously, it is imperative to estimate the size of the border effect in developing countries where nontariff barriers are very significant and nominal exchange rate variability is much pronounced. In most of the empirical studies, data from developed countries have been used to determine the size of the border effect. There are at least three reasons for this. First, we can get a long time series data only for developed countries. Second, data from developed countries are more reliable. Third, the goods market arbitrage condition seems more plausible for developed countries as information dissemination is not very costly. Due to lack of reliable and long time series data, a few attempts have been made to test LOP in developing countries.

As a matter of fact, no attempt has been made to test LOP using disaggregated data for developing countries. As aggregated data are hard to come-by, the disaggregated price data for different locations in developing countries are virtually nonexistent. In this paper, we have made an attempt to test LOP by gathering disaggregated time series price data at a number of locations in two developing countries: Bangladesh and India.

We have found that the variability of the price of a good at locations in different countries (one location in Bangladesh and another in India) is significantly higher than the variability of the price of the same good at different locations in the same country. This means that crossing the border adds a significant amount of variability in the consumer price also in developing countries. In addition to this, the magnitude of the difference in the variability has shown a time dimension. The differences in variability of prices across versus within country were greater in the 1970s compared to those in the 1980s.

This paper contributes to the border effect literature in three ways. First, while all the studies in this literature have used disaggregated price data from developed countries, this paper deals exclusively with disaggregated price data from developing countries. Like developed countries, the border effect on price variability is found to be very large for these two developing countries. Second, this paper also shows that the border effect is comparatively smaller in the second period of the sample. Therefore, time variations of border effect as observed by Engel and Rogers (2000) and Parsley and Wei (2001) need to be consistently addressed in border effect calculation. Third, effects of some of the variables deemed as the proximate factors for border effect are evaluated. It is found that the nontariff barrier and the nominal exchange rate variability are important factors in determining the price variability at locations across a border, but they are inadequate to explain the observed very large border effect.

---

1 Cost of doing business or corruption can be an indicator for nontariff barrier.

2 Bahmani-Oskooee (1993), Boyd and Smith (1995), and others have conducted studies with panel data on a number of developing countries. While Lyons (1991) has tested PPP for Peru, Baghestani (1997) has tested PPP for India in presence of black market for foreign exchange. All these are done with aggregated data.
This paper is structured as follows: Section 2 contains a brief discussion on LOP and the border effect, Section 3 contains the methodology and description of data, in Section 4, the results are reported, and at the end, we have made some concluding remarks.

2. The law of one price and the border effect

The international trade version of the LOP implies that the following must hold for any good $i$:

$$P_t(i) = P^*(i) + S_t + T_t$$

where $P_t(i)$ is the log of the time-$t$ domestic currency price of a good $i$, $P^*(i)$ is the log of the time-$t$ foreign currency price of the good $i$, $S_t$ is the log of time-$t$ domestic currency price of the foreign currency, and $T_t$ is the log of transportation costs. The no arbitrage condition in the goods market is the main logic behind this law. The very nature of this transportation cost $T_t$ remains an unsolved issue, and it should include the transaction costs as well, argued by some authors. Therefore, the burden of explaining the differences in prices of the same commodity\(^3\) at different locations rests on the transportation and transaction costs. Here, transportation and transaction costs are supposed to take into account distance between two locations, tariffs, quantitative restrictions, exchange rate uncertainty, nontraded inputs, and other barriers to trade.

We have followed the methodology in Engel and Rogers (1996) to calculate the variations of the relative price at different locations to get an idea about the size of the border effect. The standard deviation of the log of the relative price is our metric of price variability. In fact, we have calculated the standard deviation of $P_t(i) - P^*_t(i) - S_t$. According to Eq. (1), essentially we have calculated the standard deviation of the transportation and transaction costs. As transportation and transaction costs between two locations do not change dramatically over a short period of time, we expect a small variability in relative price. As a corollary to this, we expect a smaller transportation and transaction costs for the pairs of cities within the same country, and, at the same time, we expect no systematic difference in the standard deviation of these costs for cross-country city pairs.

Recent evidence suggests the opposite. Engel and Rogers (1996) and Parsley and Wei (2001) have found a large difference between the standard deviation of the relative price in cross-country city pairs compared to that for in-country city pairs, i.e. a large border effect. Engel and Rogers (2001a,b) and Parsley and Wei (2001) have examined possible factors responsible for large border effects, even though they have examined a large number of potential suspects like the presence of nontraded services, exchange rate variability, shipping costs, and geography with limited success.

The presence of a big border effect between the USA and Canada (Engel and Rogers, 1996), the USA and Japan (Parsley and Wei, 2001), the USA and European Countries

---

\(^3\) Some authors have argued that goods should be defined with a time and location dimension (for example, Debreu, 1959). Accordingly, a good in a certain location and the same good in another location are not the same economic objects.
(Engel and Rogers, 2001b; Goldberg and Verboven, 1998), and between European countries and some newly industrialized countries (Haskel and Wolf, 2001) poses a challenge to identify the sources of these border effects. Examining price variations for the same store across many countries, Haskel and Wolf (2001) came to a conclusion that the difference in local distribution costs, local taxes, and tariffs does not explain the failure of the law of one price. They have conjectured that the strategic planning or other factors may explain the border effect (emphasis is added here).

Therefore, implicit distortions in international trading may hold the key to the explanation of large border effect. All these countries studied are developed countries, and they have less trade and tariff distortions compared to those in many developing countries. Therefore, evidence from developing countries will potentially provide guidance regarding whether implicit trade and tariff restrictions are to blame for large border effect. If we obtain similar sized border effects in developing countries, the solution may lie in areas other than distortions in international trading.

In this paper, the size of the border effect has been calculated for two neighboring countries in South Asia—Bangladesh and India. These two countries have been selected because they provide a few advantages. Prior to 1947, these countries were parts of the British India. The area comprising Bangladesh and West Bengal (a state of India) used to be known as Bengal since time immemorial. The economic activities of the people in this region are similar. Agriculture and light industry are the main activities. Bangladesh has borders with India on three sides. Of about 4246 km of border (this excludes the Bay of Bengal), Bangladesh shares a 4053-km border with India. Although there are some trade restrictions between these two countries, India still is the top trading partner of Bangladesh. Economic institutions share similar history in these two countries.

The size of the nontariff barrier between the two countries is very significant. The presence of a big unofficial market (black market) between these two countries supports this assertion (see Baghestani, 1997). Transparency International in their annual report of corruption states that

The largest country (in South Asia), India, has the strongest democratic institutions, but it is as plagued as Bangladesh, Nepal, and Pakistan by systematic public and private sector corruption. (Global Corruption Report 2001, South Asia Regional Report, p. 39)

This implies that the nontariff barrier is also very large between Bangladesh and India.

The nominal exchange rate fluctuations have been very significant between these two countries during the data period. Fig. 1 shows the nominal exchange rate of Taka/Rupee\(^4\) over 1975–1995.

It is clear from Fig. 1 that Taka has lost its value significantly in the 1980s, and it has started reclaiming ground in the late 1980s and early 1990s. This was partly due to opening up of the currency market for Bangladesh in the early 1980s (Rahman, 1992) as a

---

\(^4\) Taka and Rupee are Bangladeshi and Indian currency, respectively.
condition for structural adjustment loans, while India has started to open the foreign exchange market in the late 1980s.\textsuperscript{5} The coefficient of variation of the Taka–Rupee exchange rate for the entire period is about 20.74%. However, if we look at the coefficient of variations for two subperiods (1975–1984 and 1985–1995), the coefficient of variation is larger in the latter part of the sample (15.63% for 1975–1984 to 25.32% for 1985–1995). Overall, the amount of the nominal exchange rate variation is quite large.

The disaggregated price data for 24 cities in Bangladesh and India over 21 years have been used to measure the size of the border effect. In addition to assessing the border effect for the whole period, we have estimated border effect for two subperiods.

3. Methodology and data

We have collected annual consumer price data for 5 Bangladeshi and 19 Indian cities. The data cover the period from 1974 to 1995; for a detailed discussion of data and data sources, see Appendix A. We have aggregate consumer price index for each city as well as consumer price index disaggregated into two categories: food and clothing.

The relative prices in this paper have been calculated in the following way. Let $P_{j,k}^i(t)$ be the log of the price of good $i$ in location $j$ relative to the price of good $i$ in location $k$. All prices are converted into Taka by using the period average Taka–Rupee exchange rate for the period. For each category of goods, there are observations for 276 city pairs. For each city pair, one variability measure is calculated by computing the standard deviation of $P_{j,k}^i(t) - P_{j,k}^i(t - 1)$ using the time series on relative price. Then, we conduct our analysis based on cross section of 276 variability measures. We have compared average price variability in the cities within each country and cities across borders at first. Then we have

\textsuperscript{5} Rajaraman (1993) reports that Rupee was pegged to a secret basket of currencies in 1975. It was abandoned effectively in 1985.
used the linear regression technique to assess the importance of border, distance, and other relevant variables.

A simple regression equation has been estimated to explain the variability of $p_{j,k}^i(t) = P_{j,k}^i(t) - P_{j,k}^i(t-1)$, i.e. we have estimated the following equation,

$$V(p_{j,k}^i(t)) = \beta_1^i r_{j,k}^i + \beta_2^i B_{j,k} + \sum_{m=1}^n \gamma_m D_m + u_{j,k}$$

where $V(p_{j,k}^i(t))$ is the standard deviation of $p_{j,k}^i(t)$, $r_{j,k}^i$ is the log of the distance\(^6\) between locations, $B_{j,k}$ is the country dummy variable, and $D_m$ is the dummy variable for each city included in the regression.

How we have defined the dummy variables is of great importance since the country dummy will represent the extent of border effect. The country dummy variable $B_{j,k}$ denotes whether locations $j$ and $k$ are in different countries or not. For example, for the relative price between Dhaka and Chittagong (two cities in Bangladesh), the value of this dummy is 0. If the cities are located in different countries, the dummy variable takes the value of 1. The city dummy $D_m$ for the city $m$ takes a value of 1 when the city pair includes the city $m$. That is, for city pair $(j,k)$, the dummy variables for city $j$ and city $k$ take on values of 1. There are a number of reasons in favor of inclusion of the city dummies: there may be idiosyncratic error in some cities that make their prices more volatile on average, measurement error may exist, and the variability in one city may be high for some reasons not modeled here.

The regression equations have been estimated with alternative specifications where variability is a quadratic function of distance, not logarithmic. This means a squared distance term has been added into our regression equations in addition to a distance variable (dist). This implies that we have estimated the following equation as well,

$$V(p_{j,k}^i(t)) = \pi_1^i \text{dist}_{j,k} + \pi_2^i \text{dist}_{j,k}^2 + \pi_3^i B_{j,k} + \sum_{m=1}^n \mu_m D_m + v_{j,k}$$

Regression equations have also been estimated where all the variables are deflated by the log of the distance to capture the idea that the standard deviation of the regression errors may have been proportional to the log of distance between cities. This means the following equation has been estimated as well.

$$V(p_{j,k}^i(t)/r_{j,k}) = \phi_1^i + \phi_2^i B_{j,k}/r_{j,k} + \sum_{m=1}^n \phi_m D_m/r_{j,k} + w_{j,k}$$

The definitions of variables of this equation are the same as in Eq. (2).

Although using aggregated cross-section data Bahmani-Oskooee (1991) has shown that inflation variability can be partly explained by exchange rate variability, the strength of this result is constrained by the simultaneity between inflation variability and exchange rate variability. Recently, Engel (2001) has examined the evidence related to this issue and

\(^6\) The great circle distance between the cities in miles is our distance variable.
has come to a conclusion that exchange rate variability does not influence price variability very much. In order to separate the border effect from the effect of exchange rate variability, we have followed Engel and Rogers’s (1996) measure of cross-border relative price that does not involve exchange rate. Accordingly, we have expressed all prices of goods in a particular location relative to the overall price index of that location. For example, we take the price of food in Calcutta relative to the overall CPI of Calcutta as our price. We then compare this relative price to a similar price in a different location, such as the price of food in Dhaka relative to the CPI of Dhaka. These are nominal exchange rate-free measures. If the volatile nominal exchange rate explains the entire border effect, the border coefficient should not be significant in a regression (using Eq. (2)) with relative price constructed in this way. We observe that the border dummy is still highly significant in all these regressions.

The presence of nontraded service in commodity price is postulated as an explanation for the border effect. Therefore, the structure of the labor market deserves some attention in our regressions. As we know, the variability of the relative price between two countries depends on the variability of the relative price of nontraded services, which can be approximated by the relative wages between locations. We expect that by inclusion of the standard deviation of the relative wage as an additional right-hand side variable, the explanatory power of the country dummy should decline. Since we are able to gather location-specific wage data for only 5 Bangladeshi cities and 8 Indian cities, we have estimated the regression equation for 13 cities over the period 1976–1995.

All these calculations are done for a full sample period and for two subperiods (1974–1984 and 1985–1995). In 1985, the South Asian Association for Regional Cooperation (SAARC) was established with a mandate of more regional cooperation including a promise to create South Asian Preferential Trading Agreement (SAPTA). Therefore, we have two subsamples and the dividing date is 1985. The results of these two subperiods will help us in assessing the changes in the consumer price variability before and after the SAARC was established.

4. Results

In order to identify any systematic variation in the relative prices for cross-country city pairs, we have calculated the standard deviation of log difference of the relative price. Selected summary statistics are reported in Tables 1.A–1.C. The average standard deviations of log difference of the relative price for pairs of cities that are (i) both in Bangladesh, (ii) both in India, and (iii) one in each country for all the categories are reported. The average price variability for the full sample, the first period (1975–1984), and the second period (1985–1995) are reported in Tables 1.A–1.C, respectively.

These tables reveal that the variability of the relative prices at locations in each country is smaller than that for the cross-country locations. The cross-country average relative

---

7 The cities are Dhaka, Chittagong, Rajshahi, Khulna, Narayanganj, Ahmedabad, Bangalore, Bombay, Nagpur, Sholapur, Madras, Kanpur, and Delhi.
price variability is more than three times higher than that for locations in the same country. As the average distances for cross-country cities are higher, it is tempting to argue that the differences in variability of relative prices are due to distance between locations. To shed some light on that, we will assess the contribution of distance in relative price variability more rigorously using regression analyses later. Yet, the sheer size of the difference indicates that crossing a border adds a significant amount of variability to the relative price. This is true for both individual items and also for CPI. It is also interesting to note that average relative price variability for Bangladeshi city pairs is very close to that of Indian city pairs even though the average distance is much higher for Indian city pairs. This enables us to suggest that the importance of distance in explaining the difference in average relative price variability is overemphasized.

When we have divided the whole sample into two subperiods, the average relative price variability has declined significantly in the later part of the sample. For both Bangladeshi and Indian city pairs, the average relative price variability is much lower in the later part of the sample for almost all categories. The decline is more pronounced for Bangladeshi city pairs than for Indian city pairs. Also, at the same time, the size of the average relative price variability declined significantly for cross-country city pairs. Even though the relative price variability for cross-border city pairs for the later part of the sample is almost half of that for the previous period, still it is equal to at least three times of the price variability of Bangladeshi city pairs and at least two times of the price variability of Indian city pairs.

<table>
<thead>
<tr>
<th>Category</th>
<th>Bangladesh–Bangladesh</th>
<th>Bangladesh–India</th>
<th>India–India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>0.0383</td>
<td>0.1720</td>
<td>0.0550</td>
</tr>
<tr>
<td>Clothing</td>
<td>0.0669</td>
<td>0.1630</td>
<td>0.0510</td>
</tr>
<tr>
<td>CPI</td>
<td>0.0430</td>
<td>0.1591</td>
<td>0.0399</td>
</tr>
<tr>
<td>No. of pairs</td>
<td>10</td>
<td>95</td>
<td>171</td>
</tr>
<tr>
<td>Average distance (mi)</td>
<td>122.3</td>
<td>721.9</td>
<td>633.6</td>
</tr>
</tbody>
</table>

*Measured by standard deviation of $\frac{P_{j,k}^i(t) - P_{j,k}^i(t-1)}{C_0^i P_{j,k}^i(t-1)}$, where $P_{j,k}^i$ is the log of the price of good i in location j relative to the price of good i in location k.*

<table>
<thead>
<tr>
<th>Category</th>
<th>Bangladesh–Bangladesh</th>
<th>Bangladesh–India</th>
<th>India–India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>0.0518</td>
<td>0.2418</td>
<td>0.0611</td>
</tr>
<tr>
<td>Clothing</td>
<td>0.0891</td>
<td>0.2018</td>
<td>0.0412</td>
</tr>
<tr>
<td>CPI</td>
<td>0.0587</td>
<td>0.2175</td>
<td>0.0426</td>
</tr>
<tr>
<td>No. of pairs</td>
<td>10</td>
<td>95</td>
<td>171</td>
</tr>
<tr>
<td>Average distance (mi)</td>
<td>122.3</td>
<td>721.9</td>
<td>633.6</td>
</tr>
</tbody>
</table>

*Measured by standard deviation of $\frac{P_{j,k}^i(t) - P_{j,k}^i(t-1)}{C_0^i P_{j,k}^i(t-1)}$, where $P_{j,k}^i$ is the log of the price of good i in location j relative to the price of good i in location k.*
Although the exchange rate pass-through literature remains inconclusive about the one-to-one relationship between relative price and exchange rate fluctuations, we have examined the relative–relative price formulation suggested by Engel and Rogers (1996) to have an exchange rate-free measure of relative price. We have defined the price of each category at each place relative to overall CPI of that place as our initial price variable. For example, now our exchange rate-free relative price for food between Dhaka and Chittagong is defined as the following: 

\[ \frac{\text{Food}_{t,\text{Dhaka}}}{\text{CPI}_{t,\text{Dhaka}}} / \frac{\text{Food}_{t,\text{Chittagong}}}{\text{CPI}_{t,\text{Chittagong}}} \]

Using this definition of relative price, we have also calculated the variability of the relative price. The average variability of the relative price calculated with this new definition is reported in Table 2. Here again the average variability for cross-country city pairs is higher than that for same-country city pairs.

Table 2 reveals that the exchange rate-adjusted relative–relative price variability is much lower for both same-country city pairs and cross-country city pairs (comparing results reported in Tables 1.A and 2). This implies that the nominal exchange rate variability is a factor in determining the size of the relative price variability. Still for the cross-country city pairs, relative price variability is almost double compared to that for the same-country city pairs. It is also interesting to note that the relative price variability for the same-country city pairs is almost the same for both Bangladesh and India even though the Indian city pairs are farther apart. This again weakens the importance of distance in explaining the large difference in relative price variability between same-country city pairs and cross-country city pairs. From this, at least we may conclude that there exists a large border effect between Bangladesh and India.

Table 1.C
Average relative price variability (for period 1985–1995)*

<table>
<thead>
<tr>
<th>Category</th>
<th>Bangladesh–Bangladesh</th>
<th>Bangladesh–India</th>
<th>India–India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>0.0188</td>
<td>0.0717</td>
<td>0.0441</td>
</tr>
<tr>
<td>Clothing</td>
<td>0.0333</td>
<td>0.1041</td>
<td>0.0558</td>
</tr>
<tr>
<td>CPI</td>
<td>0.0176</td>
<td>0.0757</td>
<td>0.0337</td>
</tr>
<tr>
<td>No. of pairs</td>
<td>10</td>
<td>95</td>
<td>171</td>
</tr>
<tr>
<td>Average distance (mi)</td>
<td>122.3</td>
<td>721.9</td>
<td>633.6</td>
</tr>
</tbody>
</table>

* Measured by standard deviation of \( P_{j,k}^{t}(t) - P_{j,k}^{t}(t-1) \), where \( P_{j,k}^{t} \) is the log of the price of good i in location j relative to the price of good i in location k.

Table 2
Average of relative–relative price variability (for period 1975–1995)

<table>
<thead>
<tr>
<th>Category</th>
<th>Bangladesh–Bangladesh</th>
<th>Bangladesh–India</th>
<th>India–India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food/CPI</td>
<td>0.0251</td>
<td>0.0365</td>
<td>0.0282</td>
</tr>
<tr>
<td>Cloth/CPI</td>
<td>0.0591</td>
<td>0.0989</td>
<td>0.0555</td>
</tr>
<tr>
<td>No. of pairs</td>
<td>10</td>
<td>95</td>
<td>171</td>
</tr>
<tr>
<td>Average distance (mi)</td>
<td>122.3</td>
<td>721.9</td>
<td>633.6</td>
</tr>
</tbody>
</table>
4.1. Regression results

In order to determine how much of the variation of the relative price variability depends on distance and other variables, we have estimated regression equations described in Section 3. These regression results are reported in Tables 3–5.

In Table 3, we have reported the regression results using alternative specifications. It is crystal clear that the border dummy is highly significant irrespective of the specifications of the model. This is true for all categories including the relative–relative price when the commodity price is defined as a ratio of Consumer Price Index (CPI) at each location. For specification 1 (where the city dummy, the log of the distance, and country dummy variables are included), distance variable is not significant for food and CPI, while for all other categories, it is highly significant. It is interesting to note that the distance variable is not significant for food, while it is highly significant for the exchange rate-adjusted food price (Food/CPI). Similarly, the size of the $t$-statistic for distance in the clothing regression increases when we take the exchange rate-adjusted clothing price as the dependent variable.

At the same time, the border coefficient (country dummy) becomes smaller for the exchange rate-adjusted prices, while the coefficients for the log of the distance do increase. It implies that the presence of distortions due to nominal exchange rate variability may have added some noise that makes the border coefficient very large.\footnote{We do not have data disaggregated enough to include nominal exchange rate variability explicitly in regression as done by Parsley and Wei (2001). Therefore, we have adopted an indirect way to take into account the exchange rate variability due to Engel and Rogers (1996).} Still the border coefficient is highly significant for the exchange rate-adjusted consumer prices. In addition to this, the observed reduction in the adjusted $R^2$ suggests that the nominal exchange rate variability influences the (unadjusted) relative price variability (comparing adjusted $R^2$ Food and Clothing versus Food/CPI and Clothing/CPI regressions, respectively). This in turn provides an indirect clue to the size of the exchange rate pass-through. Nevertheless, these results suggest that the nominal exchange rate variability is an important contributing factor in cross-border price variability but still there is a large border effect.

The results from specification 2 of the model where distance and distance squared are included as regressors may suggest that the results are against a quadratic distance function. We do not find a significant distance and distance squared coefficient for any single category of items. Moreover, the adjusted $R^2$ remains almost the same for all specifications. Nonetheless, the consensus is that crossing a border adds a significant amount of variability to the relative price.

Even though we have reported White’s (1980) heteroskedasticity-consistent standard errors, we have tested another specification of the model where all the variables are deflated by the log of the distance variable (specification 3) to neutralize any possibility that the variance of the error term might be greater for more distant cities. We have found a highly significant positive constant term and also a highly significant border coefficient for all categories.
In order to determine whether the border effect declines over time or not, we have divided our data into two subsamples. One subsample covers the period 1975 through 1984, and the other subsample covers the period 1985–1995. Regression results are reported in Table 4.

From this table, it is clear that the size of the border coefficient is much lower for every case (compare column 3 to column 6 in Table 4). The coefficient for the border dummy has
declined from 0.1843 for the food price in the first period to 0.0378 for the same in the second period. Similarly, for the clothing regression, the coefficient for the border dummy declines by more than half in the second period, while the border coefficient for CPI declines by about 75% in the second period. These could be the results of improvement in communication networks and the easing of tariff restrictions in the second half of the sample period.

Since the time series we have used in this study is not very long, we should be cautious about the interpretations of the results from subsamples. Still, we can argue with confidence that the size of the border effect remains very large. For food, clothing, and CPI, the adjusted $R^2$’s are much lower in the second period. This indicates that left-out variables are more prominent in the second period. One prime candidate is the nominal exchange rate variability, but looking at the regression results from the nominal exchange rate-adjusted variables, Food/CPI and Clothing/CPI, we cannot argue strongly in favor of that. The adjusted $R^2$ is higher for Food/CPI in the second period, while it is lower for Clothing/CPI.\(^9\) Even though the size of the coefficient of the border dummy for the exchange rate-adjusted relative prices is lower in the second period of the data, the size of the border coefficient remains very large and highly significant.

Engel and Rogers (2000) have argued that the variability of the relative price between two locations may depend on the variability of relative prices of nontraded services. Since nontraded goods and services markets are organized locally, the presence of a border may exacerbate the effect of nontraded service in the relative price. Labor input in price formation has been the main nontraded component. Thus, the wage variability is a good measure to account for the nontraded services. We expect a positive relationship between the wage variability and the relative price variability. Table 5 contains the regression results for specification 1 and another specification (specification 4) where wage variability is included as a regressor.

\(^9\) Nominal exchange rate was more volatile in the second period (discussed in Section 2).
We have found that the coefficients for wage variability for food, clothing, and CPI are positive and highly significant. Although the adjusted $R^2$ remains almost the same before and after the inclusion of wage variability as a right-hand side variable, the coefficients for the log of the distance and the border dummy decline significantly. Therefore, the presence of nontraded services remains an important source of the variability of the relative price. When we consider the nominal exchange rate-adjusted prices for food and clothing (Food/CPI and Clothing/CPI), the coefficients for the wage variability are much smaller and not significant. For the nominal exchange rate-adjusted clothing price (Clothing/CPI), the coefficient is negative. This implies that the wage rate variability assumes some role of the exchange rate variability in the regression with the unadjusted prices. The presence of the large and highly significant border dummy for nominal exchange rate-adjusted prices suggests that the variability of the relative prices of the nontraded services does not account for a large border effect.

In order to get some idea about the economic significance of the border relative to the distance variable, Parsley and Wei (2001) have suggested the following formula to calculate how much additional distance we need to add to the average distance between two countries to generate as much price variability as we observed between Bangladesh and India: $\beta_1 \ln (\text{dist} + Z) = \beta_2 + \beta_1 \ln (\text{dist})$, where dist is the average distance between Bangladesh–India city pairs (721.9 mi), $\beta_1$ and $\beta_2$ are the coefficient estimates from Eq.

### Table 5
Regression results explaining relative price variability (time period 1976–1995)

<table>
<thead>
<tr>
<th>Category</th>
<th>In (Distance)</th>
<th>Border dummy</th>
<th>Wage</th>
<th>Adjusted $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specification 1</td>
<td>0.0063 (2.576)</td>
<td>0.0435 (10.80)</td>
<td></td>
<td>0.93</td>
</tr>
<tr>
<td>Specification 4</td>
<td>0.0036 (1.732)</td>
<td>0.0264 (4.737)</td>
<td>0.4815 (3.236)</td>
<td>0.94</td>
</tr>
<tr>
<td><strong>Clothing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specification 1</td>
<td>0.0092 (2.435)</td>
<td>0.0427 (7.278)</td>
<td></td>
<td>0.93</td>
</tr>
<tr>
<td>Specification 4</td>
<td>0.0077 (1.908)</td>
<td>0.0328 (4.621)</td>
<td>0.2784 (1.975)</td>
<td>0.94</td>
</tr>
<tr>
<td><strong>CPI</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specification 1</td>
<td>0.0042 (1.761)</td>
<td>0.0446 (13.56)</td>
<td></td>
<td>0.94</td>
</tr>
<tr>
<td>Specification 4</td>
<td>0.0018 (0.651)</td>
<td>0.0287 (5.552)</td>
<td>0.4475 (3.571)</td>
<td>0.96</td>
</tr>
<tr>
<td><strong>Food/CPI</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specification 1</td>
<td>0.0006 (0.804)</td>
<td>0.0103 (7.446)</td>
<td></td>
<td>0.85</td>
</tr>
<tr>
<td>Specification 4</td>
<td>0.0004 (0.552)</td>
<td>0.0093 (4.927)</td>
<td>0.0294 (0.693)</td>
<td>0.85</td>
</tr>
<tr>
<td><strong>Clothing/CPI</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specification 1</td>
<td>0.0013 (0.816)</td>
<td>0.0139 (4.024)</td>
<td></td>
<td>0.83</td>
</tr>
<tr>
<td>Specification 4</td>
<td>0.0023 (1.238)</td>
<td>0.0203 (3.305)</td>
<td>$-0.1789 (-1.319)$</td>
<td>0.84</td>
</tr>
</tbody>
</table>

Dependent variable: relative price variability.
The sample period is 1976–1995. We estimate White heteroskedasticity-consistent standard errors and report $t$-statistics in the parenthesis. In specification 1, along with city dummy variables for each city, the log of the distance and the border dummy are included. In specification 4, we have added the relative nominal wage variability as regressor in specification 1. There are 78 observations in each regression.
(2), and the distance equivalent of the border effect is \( Z \). The estimated values are really big numbers. This is consistent with the Parsley and Wei (2001) findings.

5. Conclusions

The results show that both distance and border are very important in explaining price variability in Bangladesh and India. We have also evaluated the contributions of some of the variable in generating the variability of consumer prices. Exchange rate uncertainty and the presence of nontraded goods in consumer price indices are unable to explain the large border effect in developing countries. It should be mentioned that for the use of yearly data, some of the variations in prices are already evened out. Yet, we find a very big border effect on the prices in Bangladesh and India. We have also observed that the variability of prices declined a little in the second half of the sample period. As Helliwell (1998) has argued that due to the improvement in the efficiency of transportation of goods or communications or marketing, the effect of distance declines over time. Since the size of the border between Bangladesh and India is comparable to that found between the USA and Canada, assuming that the resolution of large border effect lies on nontariff barriers seems inadequate. However, as a by-product of the calculation of border effect with consumer prices and exchange rate-adjusted consumer prices, we may indirectly get a measure of the exchange rate pass-through for developing countries.

Acknowledgements

I would like to thank Charles Engel, Kevin Spradlin, Nandini Abedin, and Afroza Hasin for their valuable input in this paper. I would also like to thank seminar participants to 2001 South-East Economic Theory and International Economics Conference at Miami. The constructive suggestions of two referees are also gratefully acknowledged. The usual disclaimer applies.

Appendix A. Data and data sources

Data related to Bangladesh were collected from various issues of Economic Trends, a monthly publication of the central bank of Bangladesh: Bangladesh Bank. Indian consumer price data were collected from different issues of Statistical Abstract India published by the Central Statistical Organization, India. The annual period average exchange rates are collected from the International Financial Statistics Yearbook, 1997 published by the IMF. Taka–Rupee exchange rate is calculated by dividing Taka/US$ exchange rate by Rupee/US$ exchange rate. Wage data for India are gathered from various

---

10 For example, the size of the border for exchange rate-adjusted food price regression is 260404 mi (this is the smallest distance calculated).
issues of Indian Labour Journal. “Earnings (Basic wage and dearness allowance) of the lowest paid workers/operatives in Cotton Textile Mills” is the wage rate we have used here. Bangladeshi wage data are collected from the Statistical Yearbook of Bangladesh. Annual average daily wage rate of construction labor (mason) at a principal town is our wage rate for Bangladesh.

We collected the latitude and longitude of different cities from United Nations Statistics. http://www.un.org/Depts/unsd/demog/050.htm is the source of Bangladeshi data, while http://www.un.org/Depts/unsd/demog/356.htm is the source for Indian data. Using “how far is it” website (http://www.indo.com/distance/), we have calculated the distance data in miles.

References


Engel, C., Rogers, J.H., 2001a. Violating the law of one price: should we make a federal case out of it? Journal of Money, Credit and Banking 33, 1–15.


