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Abstract: The observed excess price variability in cross-border city pairs compared to that in within-country city pairs has been defined as the "border effect." We used a unique data set from cities that were in the same country at one time and were in two separate countries later on to examine the effects of the presence of a national border on price variability. Interestingly a border-like effect was detected even during the period when all the cities were in the same country. We also found a large border effect when cities were in two separate countries. However, we found no change in the price variability at cross-border city pairs during the periods both before and after the cities separated into two different countries. This finding suggests that the observed systematic higher variability of consumer prices in cross-border city pairs might not be due to the presence of a border as suggested in the literature.

JEL Classification: F40, F41. **Keywords**: Border effect; Law of one price.

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I. Introduction

In the context of international trade, the Law of One Price has received more attention lately. Using U.S.A. and Canadian city price data, Engel and Rogers (1996) showed that the standard deviation of the relative price in U.S. and Canadian cities is systematically higher for cross-border city pairs than for city pairs within a country. For example, the price variability between Detroit and Toronto is much higher than between Detroit and San Francisco or between Toronto and Vancouver. Other researchers provided more support to these results with data from other developed countries (Goldberg and Verboven, 2001; Parsley and Wei, 2001; Haskel and Wolf, 2001) and developing countries (Morshed, 2003). What causes this failure of the Law of One Price in the short-run remains an unresolved issue.

Although nominal exchange rates and transport costs have been found to be significant in determining cross-border price variability, still the observed price variability in cross-border city pairs can not be explained by these factors alone. Researchers have suggested that the presence of a national border might be the source of this excess price variability in cross-border city pairs. This excess variability has been coined as the border effect. In order to identify the sources of this border effect, some researchers have examined the role of prices of nontraded goods and services (Engel and Rogers, 1996; Morshed, 2003), others have examined social variables such as language (Engel and Rogers, 2000), while another group of researchers has looked into geographic features (Parsley and Wei, 2001). Nonetheless, all these attempts can explain only a small portion of this large and significant border effect.

Researchers generally follow a *with or without a border* framework to calculate border effects where they compare the price variability at the city pairs located in different countries to that at the city pairs located within a country. A *with or without a border* framework certainly seems important in understanding the differences in price variability, yet to say that the presence

of a national border causes this increased price variability seems oversimplified. In order to isolate the effects of the creation of a national border, we believe that a complementary *before and after* framework is warranted where data from cities that were parts of the same country for a period and became parts of different countries later on are examined. Generally, it is very difficult to get data with these properties, but the recent history of the Indian Subcontinent, in general, and Bangladesh and Pakistan, in particular, opens up an opportunity to conduct a natural experiment with a *before and after* framework. Bangladesh (then East Pakistan) and Pakistan (then West Pakistan) were two parts of the same country (Pakistan) during 1947-1971. Bangladesh became an independent nation in 1971. This break-up of a country into two independent nations allowed us to examine the effects of a new border on price variability. Accordingly, we have collected price data at five cities each in both Bangladesh and Pakistan for both the pre-1971 and the post-1971 periods. This unique data set will allow us to appraise the border effect more rigorously.

The geographic non-contiguity of Bangladesh and Pakistan will not hinder our analysis so long as they trade goods and services[1]. Previously, data from two physically disjoint countries have been used to estimate the border effect. For example, Parsley and Wei (2001) estimated the size of the border effect between the U.S.A. and Japan. Other researchers have used a large cross-country dataset that includes data from non-contiguous countries (Goldberg and Verboven, 2001; Haskel and Wolf, 2001).

[1] Trading between these two regions of the country was very high during the pre-1971 period. Export-import data were reported generally for the whole country (both East Pakistan and West Pakistan) during the pre-1971 period. However, there are also some inter-wing trade data (from East Pakistan to West Pakistan and *vice versa*). Import of East Pakistani products via Karachi port (the main seaport in West Pakistan) and import of West Pakistani products via Chittagong port (the main seaport in East Pakistan) together was about 22.9% of the total export and import of Pakistan during the 1950s and 1960s. West Pakistan's imports from East Pakistan included, among other commodities, pulses, fruits and vegetables, and chilies, while East Pakistan's imports from West Pakistan included, among other commodities, flour, gram, mustard oil, ghee, gur, and soap. After 1971, the amount of trading between Bangladesh and Pakistan declined significantly. Still, Pakistan is an important trading partner of Bangladesh. In 1991, Bangladesh imported 1.7% of its total imports from Pakistan and exported 2.3% of its total exports to Pakistan.

Generally the border effect is estimated by the border dummy coefficient in a regression equation where price variability has been regressed on log of distance, a border dummy, and other relevant variables. In this paper, we have followed the same *with or without a border* technique with an *assumed border* between cities in Bangladesh and Pakistan even during the pre-1971 period. Interestingly enough, we found that this *assumed border* is highly significant for a number of commodities. As expected, we also found a highly significant border coefficient for the post-1971 period. These estimated larger border coefficients with better precision (larger t-statistics) from the post-1971 data certainly indicate the presence of a border effect under a *with or without a border* framework. But in a *before and after framework*, price variability at only *cross-border city pairs* during both the pre- and post-1971 periods were evaluated. Our results show that for a number of commodities the independence of Bangladesh (creation of a border) did not raise the price variability at cross-border city pairs.

The present paper consists of five sections. In section II, we discuss the basic feature of the dataset and why this dataset is suitable to appraise the border effect in a *before and after framework*. We discuss methodology in section III. Results are reported in section IV. At the end, some concluding remarks are made.

II. Data and Data Sources

We have compiled a three-dimensional panel dataset consisting of annual retail price for 14 traded goods at 10 different cities in Bangladesh and Pakistan (five cities from each country). The pre-1971 data ranges from 1950-1971, while the post-1971 data is for the period 1975-1993. Five Bangladeshi cities are Dhaka, Chittagong, Narayanganj, Saidpur, and Sylhet,[2] while Karachi, Lahore, Peshwar, Rawalpindi, and Sialkot are Pakistani cities. We include the following

[2] Data from Saidpur are not available for post-1971 Bangladesh, but we have data for Rangpur. Since Saidpur and Rangpur cities are from the same district and not far from each other, we consider these two as the same city for our purpose.

traded goods: flour, *moogh* (pulse), gram, beef, mutton, milk, *ghee* (processed butter), potatoes, mustard oil, onion, *gur* (molasses), chilies, kerosene oil, and washing soap. These are major consumer items in Bangladesh and Pakistan. With the exception of kerosene oil, all these commodities are produced in both countries.

This is a very unique data set for at least three reasons. First, we have data for a number of cities that were part of the same country for a time and then later were in two different countries. This enables us to directly determine how much the independence of Bangladesh, essentially the creation of a national border, changes the price variability in cross-border cities. Second, unlike many other studies that use price indices, we use actual price data. The Law of One Price seems more naturally related to the price of a particular commodity than to a price index. Third, unlike cross-country studies, the quality of the data is not compromised by the use of different datasets from different sources. The same Statistical Bureau is the source for the pre-1971 data for both countries and the similarity of the structure of the statistical bureaus and the data definitions keep the potential variability to a minimum for the post-1971 period.

The pre-1971 price data for all cities were collected from *25 Years of Pakistan in Statistics 1947-72,* a 1972 special publication of the Central Statistical Office of Pakistan. For post-1971 Bangladeshi data, we consulted various issues of *Monthly Statistical Bulletin of Bangladesh,* published by the Bangladesh Bureau of Statistics. Post-1971 Pakistani data were collected from *50 Years of Pakistan in Statistics (Volume IV) 1947-1997,* a special publication of the Federal Bureau of Statistics of the Government of Pakistan.

We obtained the latitude and longitude of different cities from United Nations Statistics on the web at http://www.un.org/Depts/unsd/demog/. We also consulted *Oxford Atlas of the World, Ninth Edition,* for latitude and longitude data for a few cities. Using the "How Far Is It?"

website (http://www.indo.com/distance/), we calculated the great circle distance between the cities in miles.

III. Methods

We, like Engel and Rogers (1996), define $P^i_{j,k}$ to be the log of the price of good i in location j relative to the price of good i in location k. For each city pair (j,k), the standard deviation of $p^i_{j,k} = P^i_{j,k}(t) - P^i_{j,k}(t-1)$, over all relevant years t, is the measure of price variability. The difference in relative price was taken to avoid the issue of nonstationarity of data. As there are 10 cities in our analysis, we have 45 city pairs; of these 45 city pairs, 25 city pairs are such that one of the cities is in a different country. We conducted our analysis based on the cross section of these price variability measures. Linear regression techniques were used to assess the importance of, among other variables, the presence of border and the distances between the cities.

We estimated the following equation using the Ordinary Least Squares (OLS) method:

$$S(p^i_{j,k}(t)) = b^i_1 r_{j,k} + b^i_2 B_{j,k} + \sum_{m=1}^{n} g^i_m D_m + u^i_{j,k} \qquad (1)$$

where $S(p^i_{j,k}(t))$ is the sample standard deviation of $p^i_{j,k}(t)$, $r_{j,k}$ is the log of the distance measured in miles between locations, $B_{j,k}$ is the cross-country dummy, and D_m is the dummy variable for each city included in the regression. The country dummy variable $B_{j,k}$ denotes whether location j and k lie in different countries. For example, for the relative price variability between Dhaka and Chittagong (two cities in Bangladesh), the value of this dummy is 0, whereas for the relative price variability for cities like Dhaka and Karachi (a Pakistani city) the dummy

variable takes the value 1. The city dummy[3] D_m for the city m takes a value 1 when the city pair includes the city m.

In order to determine the effects of the independence of Bangladesh, we estimated an equation with an *independence* dummy along with cross terms with other variables as regressors. Accordingly, we stacked price variability data for both the pre- and post-1971 periods and estimated the following equation:

$$S(p^i_{j,k}(t)) = a^i_1 + a^i_2 Independence + b^i_1 * r_{j,k} + g^i_1 r_{j,k} * Independence + b^i_2 * B_{j,k} + g^i_2 * Independence * B_{j,k} + \sum_{m=1}^{9} d^i_m D_m + \sum_{m=1}^{9} y^i_m Independence * D_m + u^i_{j,k}(t) \quad (2)$$

where *independence* takes a value 1 for post-1971 data, 0 otherwise. If the creation of a border does increase the relative price variability, we can expect g^i_2 to be positive and highly significant. Only nine city dummy variables and their interaction terms were included to avoid the dummy variable trap.

Another way to examine the effects of the creation of a new border is to check the difference, if any, between the price variability before 1971 and after 1971 only in cross-border cities. To this end, only cross-border variability measures were stacked, and we estimated the following equation for the stacked data for cross border city pairs:

$$S(p^i_{j,k}(t)) = f^i_1 + f^i_2 * r_{j,k} + f^i_3 * Independence + n^i_{j,k}(t) \quad (3)$$

In this case, we expect f^i_3 to be positive and significant. Since distances between cross-border city pairs are different and this distance influences the cross-border price variability, we have included log of distance as an additional regressor in our estimation.

[3] Engel and Rogers (1996) suggested a number of reasons in favor of inclusion of the city dummies, namely that there may be idiosyncratic error in some city data that makes 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.

IV. Results

IV. A. Border and Price Variability

To proceed, we calculated exchange-rate-free prices in order to exclude the effects on our retail prices of the fluctuations of nominal exchange rates. Following Engel and Rogers (1996), all prices were divided by the price of a different good in the same city to obtain exchange-rate-free prices. For example, the price of potatoes in Dhaka relative to the price of flour in Dhaka is used as the real price for potatoes. The same has been done for Karachi. This relative price, for example:

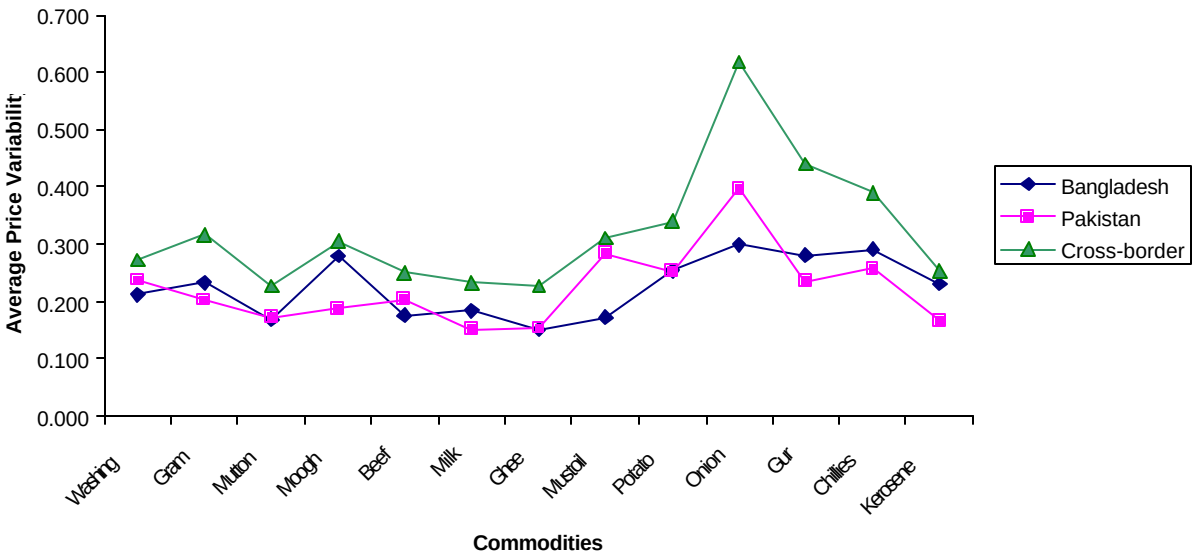
$$\frac{\Pr ice^{Potatoes}_{Dhaka,t}}{\Pr ice^{Flour}_{Dhaka,t}} \Big/ \frac{\Pr ice^{Potatoes}_{Karachi,t}}{\Pr ice^{Flour}_{Karachi,t}},$$

is a nominal exchange-rate-free price. If the volatile nominal exchange rate explains all of the border effect, the border coefficient should not be significant in a regression (using equation 1) with real relative prices constructed in this way. This is how the effects of different exchange rate regimes and the presence of nominal exchange rates are neutralized.

Average price variability at city pairs within a country and at city pairs in different countries is shown for the pre-1971 period in Figure 1 and for the post-1971 period in Figure 2. The price variability measures in cross-border city pairs were found to be higher for all commodities during both the pre- and post-1971 periods. We observed the lowest average price variability measures for washing soap, beef, mustard oil, and onion in Bangladeshi cities during the pre-1971 period. For the post-1971 period, Pakistani cities yielded the lowest price variability measures for all commodities except washing soap, gur, and kerosene oil (Figure 2). It becomes clear from a comparison of Figure 1 and Figure 2 that the average price variability in

Bangladeshi cities declined for all commodities during the post-1971 period. With the exception of gur and kerosene oil, the same is true for Pakistan. The price variability at within-a-country city pairs declined significantly after the regions were separated into two independent countries.

Figure 1: Average Price Variability in Within a Country and Cross-border Locations During the Pre-1971 Period (all prices are relative to the price of flour)



In a typical *with or without a border* framework, we compared the three series in each of Figures 1 and 2. It is evident from these figures that the price variability at cross-border city pairs was much higher compared to that at within-a-country city pairs during both the pre- and post-1971 periods. Moreover, the differences were much more pronounced during the post-1971 period (Figure 2). This yields larger border coefficients and larger t-statistics (see Table 1). Thus, the existing methodology (*with or without a border*) yields a large border effect. However, for our proposed complementary experiment (*before and after a border*) we needed to examine what has happened to the price variability *only* at cross-border city pairs during the pre- and post-1971 periods. To this end, average price variability estimates for only cross-border city pairs during both the pre- and post-1971 periods are shown in Figure 3. It is interesting to note that the price

variability at cross-border locations did not have any jump during the post-1971 period, for more than half of the commodities.

Figure 2: Average Price Variability in Within a Country and Cross-border Cities During the Post-1971 Period (all prices are relative to the price of flour)

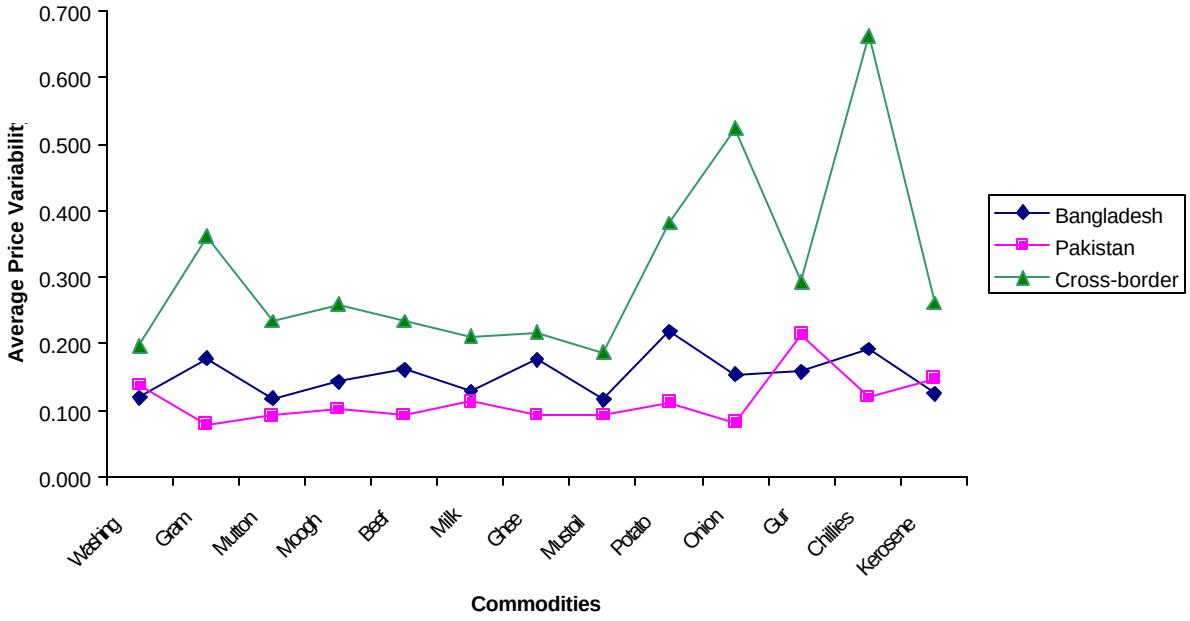
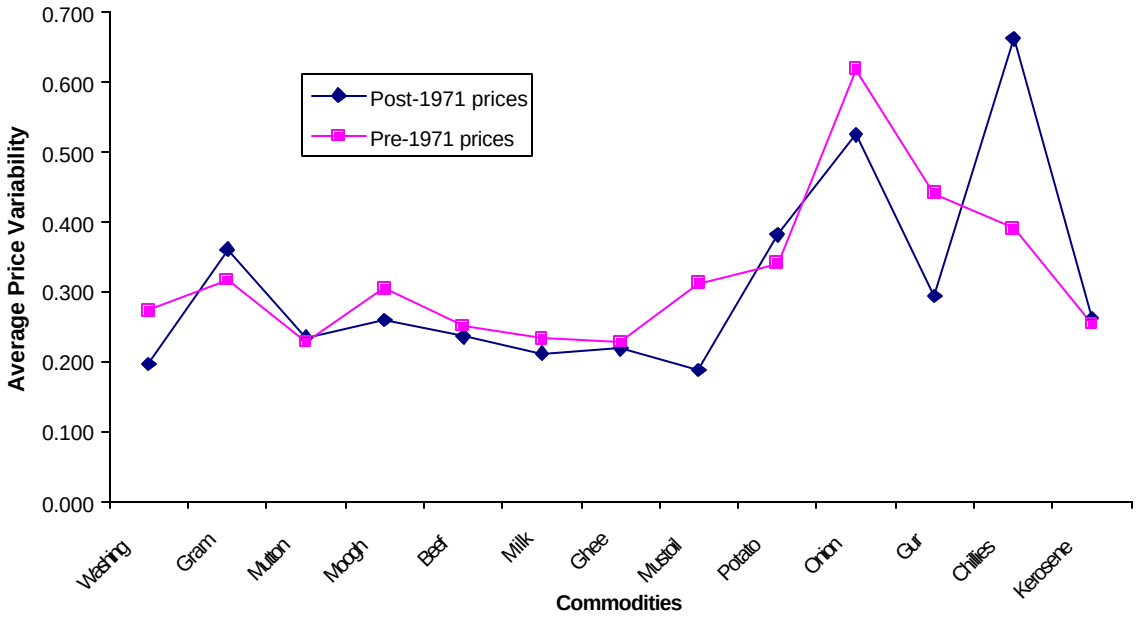


Figure 3: Average Price Variability for Cross-border City Prices in Both Pre- and Post-1971 Periods (all prices are relative to the price of flour)



In addition to this we observed lower price variability during the post-1971 period (Figure 3) for moogh, beef, milk, ghee, mustard oil, onion, gur, and washing soap. Only gram, potatoes, and chilies yielded higher price variability in the post-1971 period. These results imply that the creation of a border between these two regions does not necessarily lead to an increase in the average price variability at the cross-border city pairs.

We have estimated equation (1) and also have dealt with some variations of distance functions. In the specification I, the log of the distance and the border dummy were included along with city dummy variables for each city. In Specification II, distance, distance squared, border dummy, and city dummies are included, while in Specification III, both right- and left-hand side variables in equation (1) are divided by log (distance). Border coefficients and their t-statistics for both the pre- and post-1971 periods are reported in Table 1.

We found significant and positive border coefficients even for the period when there was no border between any cities for (column 2) beef, milk, ghee, mustard oil, onion, gur, and kerosene oil. For the post-1971 period, except for moogh, beef, ghee, potatoes, and kerosene oil under Specification II, all border coefficients are found to be positive and highly significant. We found larger border coefficients and larger t-statistics from the post-1971 data. In the context of a *with or without a border* framework, these results suggest that the creation of a border does increase the extent of the difference between the price variability at cross-border city pairs and at within-a-country city pairs. However, whether these increases in the border coefficients and corresponding large t-statistics have been the result of the creation of a border needs further investigation.

Since the average variability of prices at within-a-country city pairs declined after 1971 for both Bangladeshi and Pakistani cities and the average price variability remained almost the same for the cross-border city pairs (Figure 3), the inclusion of the same right-hand side variables in our regressions (for example, equation 1) for the post-1971 data yields larger border coefficients. The border dummy now has essentially picked up the additional differentials of price variability between within-country and cross-border city pairs. Thus, the increase in size and precision of the estimates of a border dummy in the post-1971 regressions does not necessarily imply that the presence of a border has generated such a difference.

Table 1
Border Coefficients under Different Specifications

Dependent Variable: **Price Variability** (all prices are relative to the price of flour)

Commodity	**Pre**-1971 Data			**Post**-1971 Data		
	Specification I	Specification II	Specification III	Specification I	Specification II	Specification III
Moogh	0.051 (1.840)	0.198 (3.108)	0.022 (0.888)	0.124 (5.416)	0.077 (1.287)	0.102 (5.946)
Gram	0.043 (1.540)	0.322 (4.803)	0.042 (1.437)	0.160 (7.959)	0.139 (2.859)	0.150 (9.764)
Beef	0.055 (2.802)	0.161 (3.565)	0.045 (2.415)	0.072 (4.126)	0.030 (0.561)	0.064 (4.390)
Mutton	0.022 (1.442)	0.128 (3.444)	0.020 (1.301)	0.100 (6.598)	0.084 (2.434)	0.090 (7.901)
Milk	0.081 (4.748)	0.203 (4.045)	0.074 (4.861)	0.101 (10.592)	0.148 (4.048)	0.094 (10.350)
Ghee	0.045 (3.905)	0.072 (2.199)	0.044 (3.575)	0.066 (5.608)	0.042 (0.921)	0.052 (4.756)
Mustard Oil	0.067 (2.804)	0.014 (0.303)	0.054 (2.969)	0.074 (3.681)	0.157 (5.262)	0.055 (3.414)
Potato	0.038 (1.807)	0.132 (2.287)	0.055 (2.723)	0.216 (9.086)	0.123 (1.479)	0.219 (7.602)
Onion	0.304 (6.813)	0.538 (5.149)	0.283 (7.981)	0.325 (21.182)	0.206 (3.294)	0.331 (21.951)
Gur	0.171 (5.002)	0.300 (3.170)	0.181 (6.999)	0.090 (3.251)	0.032 (0.539)	0.084 (3.725)
Chilies	0.017 (0.424)	-0.011 (-0.111)	-0.009 (-0.270)	0.437 (14.335)	0.553 (8.776)	0.411 (18.213)
Kerosene Oil	0.033 (2.383)	-0.007 (-0.281)	0.028 (2.375)	0.065 (4.227)	-0.045 (-1.214)	0.075 (5.642)
Washing Soap	0.012 (0.470)	0.152 (2.973)	0.020 (0.924)	0.078 (4.709)	0.112 (2.345)	0.067 (4.641)

Note: We have reported only the border coefficients. There are 45 observations for each of the pre- and post-1971 periods. White's heteroskedasticity-consistent standard errors were computed and t-statistics are reported in parentheses.

In order to examine the effect of the creation of a national border we estimated equation (2), which includes an *independence* dummy and other cross-terms. A small part of the results from these regressions is reported in Table 2. We expected that the coefficient for the cross-term in equation (2), g_2^i, would be positive and highly significant if the creation of a new border matters. However, we found insignificant coefficients for more than half of the 13 commodities (beef, milk, ghee, mustard oil, onion, gur, and kerosene oil). The g_2^i coefficient was found to be

negative but insignificant for gur. Thus, the observed highly significant border dummy in post-1971 with large t-statistic does not necessarily represent a large border effect.

Table 2
Regression Results with Cross-terms as Additional Regressors (Equation (2))
Dependent Variable: **Price Variability** (all prices are relative to the price of flour)

Commodity	Distance	Border	Border*Independence	Adjusted R^2
Moogh	0.011 (0.803)	0.051 (1.840)	0.072 (2.017)	0.88
Gram	0.025 (2.173)	0.043 (1.540)	0.118 (3.422)	0.91
Beef	0.004 (0.389)	0.055 (2.802)	0.017 (0.658)	0.91
Mutton	0.018 (2.585)	0.022 (1.442)	0.078 (3.663)	0.90
Milk	-0.008 (-0.973)	0.081 (4.748)	0.021 (1.056)	0.89
Ghee	0.016 (3.159)	0.045 (3.905)	0.021 (1.271)	0.93
Mustard Oil	0.008 (0.698)	0.067 (2.804)	0.007 (0.225)	0.94
Potato	0.025 (2.623)	0.038 (1.807)	0.178 (5.629)	0.88
Onion	-0.006 (-0.304)	0.304 (6.813)	0.021 (0.450)	0.96
Gur	0.008 (0.468)	0.171 (5.002)	-0.082 (-1.859)	0.88
Chilies	0.054 (2.961)	0.017 (0.425)	0.419 (8.224)	0.96
Kerosene Oil	0.011 (1.359)	0.033 (2.383)	0.032 (1.528)	0.94
Washing Soap	0.019 (1.490)	0.012 (0.470)	0.066 (2.245)	0.87

Note: White's heteroskedasticity-consistent standard errors are computed and t-statistics are reported in parentheses. There are 90 observations in these regressions. Shaded values represent significant coefficients.

IV. B. Price Variability at Cross-border Cities and the Independence of Bangladesh

We then stacked the price variability at only cross-border city pairs for both the pre- and post-1971 periods. Results of the OLS estimation of equation (3) are reported in Table 3. It is interesting to note that only for gram, potatoes and chilies do we observe a positive and significant dummy. Negative but highly significant *independence* coefficients for mustard oil, onion, gur, moogh, and washing soap suggest that the creation of a national border reduces the

cross-border price variability—a *negative* border effect indeed. We also found negative but insignificant *independence* coefficients for beef, milk, ghee, and potatoes, while for mutton and kerosene oil, positive but insignificant independence coefficients were found. This experiment indicates that the creation of a national border might not create any additional price variability at cross-border city pairs.

Table 3
Effects of Independence on the Cross-Border Price Variability
Dependent Variable: Only Cross-border Price Variability (all prices are relative to the price of flour)

Commodity	Independence	Log (Distance)	R^2
Moogh	-0.046 (-2.907)	0.0009 (0.015)	0.15
Gram	0.058 (4.009)	-0.161 (-2.200)	0.34
Beef	-0.016 (-1.066)	0.007 (0.111)	0.02
Mutton	0.007 (0.894)	-0.060 (-1.542)	0.09
Milk	-0.022 (-1.533)	-0.137 (-2.469)	0.15
Ghee	-0.010 (-0.722)	-0.136 (-2.644)	0.13
Mustard Oil	-0.123 (-10.370)	0.213 (4.756)	0.73
Potato	0.041 (2.336)	-0.029 (-0.443)	0.11
Onion	-0.079 (-6.830)	-0.154 (-2.962)	0.55
Gur	-0.148 (-9.551)	-0.184 (-3.628)	0.68
Chilies	0.281 (24.384)	0.008 (0.169)	0.93
Kerosene Oil	0.008 (0.721)	0.021 (0.399)	0.02
Washing Soap	-0.062 (-4.522)	-0.174 (-2.920)	0.40

Note: White's heteroskedasticity-consistent standard errors are computed and t-statistics are reported in parentheses.

IV. C. What Explains the "Border Effect"?

In order to understand why the presence of a national border does not increase the cross-border price variability, we need to ask the reverse question: Why do we expect that the

existence of a national border will increase the cross-border prices variability in the first place? The prevailing wisdom is that the presence of arbitrage opportunity in the market would tend to equalize prices through trading of goods and services. If the cities are in different countries, we expect more friction in trading, resulting in an increase in price variability at cross-border city pairs. However, we did not observe any jump in price variability at cross-border city pairs after the creation of a national border between Bangladesh and Pakistan in 1971. Even lower trade volume after 1971 along with the presence of a national border did not raise the price variability at cross-border city pairs. These results indicate that some degree of market segmentation may perpetuate even within a country.

V. Conclusions

Observed significant and systematically higher price variability at cross-border cities were comparable to what is found for cities located in the same country seems perplexing. These results hold even after the contributions of nominal exchange rates and transport costs are accounted for. To examine whether the presence of a national border is responsible for this or not, we collected price data from a number of cities that were part of the same country (Pakistan) for a period of time and part of a different country (Pakistan and Bangladesh) later. We conducted a natural experiment using this unique data. We found larger price variation at cross-border cities than that in within-a-country city pairs, both before and after the independence of Bangladesh. However, we found no significant difference in the price variability at *cross-border city pairs* for this political change. This suggests that the conventional border dummy approach may have detected something other than the effects of a border. In the case of the national border between Bangladesh and Pakistan, it seems that for a number of commodities there is no significant border effect. We understand that it is hard to generalize these results, yet it suggests that the unification of countries is not necessarily a recipe for quick convergence of price

variability, which might be a valuable piece of information in the context of policy making in the European Union.

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