

# **The Border Effect in Small Open Economies: Hungary and the Slovak Republic\***

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## **Abstract**

This paper examines the importance of the national border in relative price variability in two neighboring, small open economies. Using monthly frequency price data of narrowly defined, homogenous consumer products, it finds that the time-series variation in within-country relative prices is about the same in the two countries. After controlling for distance, relative price variation is significantly higher across than within countries. The border is the dominant determinant of relative prices, even after accounting for nominal exchange rate variability and local culture as represented by language spoken. Our estimates of the border effect are largely immune to the bias identified in Gorodnichenko and Tesar (2006).

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# 1. Introduction

A key issue in international macroeconomics is the response of relative prices and quantities to fluctuations in exchange rates. As a starting point in many New Open Economy Macroeconomics models, prices are fixed in the producer currency, generating Producer Currency Pricing, so that changes in the nominal exchange rate get fully passed through to local prices inducing relative price adjustment, which in turn turns on the ‘expenditure switching’ effect, making monetary policy effective under floating exchange rates. In this world, international markets are integrated, and the Law of One Price (LOOP) holds even across locations in different countries.

At the same time, while one observes a general decrease in explicit barriers – for most part quantifiable, such as tariffs, quotas, transportation costs and other physical obstacles to travel – to international trade in recent decades, the fact that international markets are more segmented than intra-national ones seems to prevail. In a seminal paper Engel and Rogers (1996) provide evidence not only on the presence of significant market segmentation as reflected in persistent cross-country price differentials of goods belonging to one product category in the US and Canada, with the volatility of price differences depending on geographical distance, but also on the national border serving as an independent source of segmentation. The findings imply that the LOOP fails both within and across countries, but more strongly so in the latter dimension.<sup>1</sup> What is particularly striking in the results of Engel and Rogers, echoed in subsequent work by Parsley and Wei (2001) and Beck and Weber (2003) is the magnitude of the ‘border effect’ in relative price differentials, the latter concept defined as the extra variability in relative prices not explained by distance *per se*. In particular, Engel and Rogers show that crossing the border between the US and Canada,

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<sup>1</sup> See also Engel and Rogers (2000) and Gorodnichenko and Tesar (2006).

countries with only minor difference in language and culture, is equivalent to traveling a distance of about 75,000 miles.

The purpose of this paper is to quantitatively evaluate the importance of the national border in price setting in two neighboring, small but similar sized economies in Eastern Europe, Hungary and Slovakia.<sup>2</sup> We focus on time-series properties of the deviations from the LOOP. After describing unconditional volatilities of good-level price differentials in the two countries, we estimate the extent to which barriers to international trade are important in explaining the relative volatility of cross-country price differentials.<sup>3</sup> We also explore some key reasons potentially explaining the size of the border effect.

The contributions of the paper are twofold. First, it investigates the impact of national borders on international price differentials in a novel and unique sample of microeconomic prices. The sample draws on data of actual, monthly frequency transaction prices of 20 very narrowly defined goods and services, observed in a total of 56 locations in two small, neighboring countries, over a period of 56 months. Relative to other similar studies seeking to provide evidence of the border effect in microeconomic prices, such as Crucini *et al* (2005),

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<sup>2</sup> The two countries are sharing a border of 680 kilometers.

<sup>3</sup> In 1994, both Hungary and Slovakia joined the Central European Free Trade Agreement (CEFTA) directed at a gradual elimination of tariffs and quotas among member countries. In CEFTA, trade in agricultural products was divided into three groups, based on their sensitivity to competition. In the first group (e.g. livestock, flowers, citrus fruits, wheat, vegetable, pastries), no duty was levied on trade within CEFTA. In the second group (e.g. beef, pork, milk, cabbage, lettuce, melons), goods sold on moderately competitive markets were included, with some reduced customs duties. In the third group (e.g. fresh eggs, poultry, cheese, onions, apples, sunflower oil, sugar, chocolate, bread), products particularly exposed to competition were included, on which custom duties and import quotas could be levied through bilateral negotiations; these were in some cases quite large. See Rytko (2002). Upon these countries joining the European Union (EU), CEFTA regulations were gradually phased out and replaced by EU ones.

Engel and Rogers (1996) and Parsley and Wei (2001) our data are specific in many ways, exhibiting both benefits and drawbacks for the purposes of the investigation. Crucini *et al* (2005) study price differentials in a large, balanced, annual frequency panel of prices of 220 goods and 84 services, observed in 122 cities around the globe, over an 11 year period. Engel and Rogers (1996) use a monthly and bi-monthly sample of price indices of 14 tradable and non-tradable product categories observed in 23 cities in Canada and the United States between June 1978 and December 1994. Parsley and Wei (2001) in a total of 96 US and Japanese cities study quarterly frequency price observations of 27 tradable products, over a period of 88 quarters. Relative to these studies, besides the geographic proximity and macroeconomic similarity of the two countries involved, the main advantage of our data set lies in the fact that the goods and services we examine are fully identical over all locations and time, and that actual transaction prices are observed at a high, monthly frequency.<sup>4</sup> These features of the data all contribute to reducing the importance of observations of relative price adjustments (or the lack of them) that are solely due to changes in the identity of products over time, across items or locations, and to alleviating censoring problems potentially present in lower frequency price data.

Second, the paper focuses on an episode where the countries involved show very similar within-country variation in price differentials. Gorodnichenko and Tesar (2006) demonstrate that the border effect estimated in previous studies confounds the impact of the

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<sup>4</sup> In terms of the homogeneity of the products, our work also relates to another literature looking at international price differentials. In these studies, focusing on one particular firm selling one (or more) specific product, the location where the item is sold and the currency in which the price is quoted are inconsequential for product characteristics. See Asplund and Friberg (2001) studying alcohol, tobacco and cosmetics prices quoted in different currencies at the same location, Ghosh and Wolf (1994) examining the cover price of *The Economist* magazine, Haskel and Wolf (2001) the prices of *IKEA* products, and Parsley and Wei (2007) the price of the *BigMac* in a number of countries worldwide.

true border and the extent of cross-country heterogeneity in relative price variability. They also suggest that altering the specification developed in Engel and Rogers (1996) in a simple way allows one to quantify the border effect relative to country specificity in relative price variability. By focusing on an episode with similar time-series variability in relative prices in the two countries, our analysis is able to get around the country heterogeneity problem in a natural way.

The rest of the paper is structured as follows. Section 2 describes the data. Section 3 compares price variability within and across countries, and Section 4 quantifies the border effect in the baseline specification. Section 5 provides information on potential determinants of the border effect. Section 6 concludes.

## 2. The Data

This study exploits a unique, detailed, three-dimensional panel data set of retail prices of 20 consumer items of very narrowly defined product attributes, observed over a period of 56 months in 20 Hungarian and 36 Slovakian districts.<sup>5</sup> Serving as the basis for the calculation of the official consumer price indices by the national statistical offices in the two countries, the data set contains actual, not quoted prices or price indices. That is, the prices recorded are transaction prices paid by consumers, inclusive of all taxes.

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<sup>5</sup> The districts in Slovakia are Bratislava, Bratislava-vicinity, Dunajská Streda, Galanta, Senica, Trnava, Považská Bystrica, Prievidza, Trenčín, Komárno, Levice, Nitra, Nové Zámky, Topoľčany, Čadca, Dolný Kubín, Liptovský Mikuláš, Martin, Žilina, Banská Bystrica, Lučenec, Rimavská Sobota, Veľký Krtíš, Zvolen, Žiar nad Hronom, Bardejov, Humenné, Poprad, Prešov, Stará Ľubovňa, Svidník, Vranov nad Topľou, Košice, Michalovce, Rožňava and Spišská Nová Ves. The main cities of districts in Hungary include Budapest, Pécs, Kecskemét, Békéscsaba, Miskolc, Szeged, Székesfehérvár, Győr, Debrecen, Eger, Tatabánya, Salgótarján, Cegléd, Kaposvár, Nyíregyháza, Szolnok, Szekszárd, Szombathely, Veszprém and Zalaegerszeg

The sample period starts in May 1997 and ends in December 2001. The data set contains prices of four categories of consumer products: durable goods (white lime, Turkish towel, plastic bucket, drawing paper, pocket calculator), meat products (beef round, pork chops, pork leg, spare ribs, pork liver, smoked bacon, pork lard), other food products (poppy seeds, sugar, flour, raisins, vinegar, dry biscuits) and services (car driving lesson, movie ticket). The products are selected so that they match the definition of a homogenous item, independently of time, store and location.

The prices are recorded in at least three different stores in a given district. Data collectors are provided with explicit instructions and data forms. They visit the stores until the 20th day of the month, and then send the price records to the particular branch of the Statistical Office. The sale points are centrally selected so that the prices are representative of the distribution of prices in the districts. In case a particular store is closed down, it is replaced by a comparable unit in the same district upon the prior approval of the Statistical Office.

As the Hungarian sample contains no store identifiers, we create district specific cross-store averages of individual price quotations in both countries, and treat these as the underlying object of investigation. The final balanced sample of prices thus contains a total of 62,720 observations. To calculate prices measured in the same currency, we employ the monthly average exchange rate as reported by the Central Banks in the two countries, using the dollar as a vehicle currency.

Finally, costs of transportation, a key potential determinant of cross-sectional heterogeneity in relative price variability are proxied by the geographical distance between locations. The distance data are obtained via the free online service of <http://viamichelin.com>.

### 3. Variability in Relative Prices

For each product, we examine relative prices measured within and across countries.

We start with defining the good-level bilateral relative price (or real exchange rate) as

$Q_{j,k,t}^i = \frac{P_{j,t}^i}{S_t P_{k,t}^i}$ , where  $P_{j,t}^i$  is the nominal price of good  $i$  at location  $j$ , at time  $t$ , and  $P_{k,t}^i$  is the

nominal price of good  $i$  at location  $k$ , at time  $t$ , where  $i = 1 \dots 20$  and  $j, k = 1 \dots 56$ .  $S_t$  is a nominal exchange rate expressed in Hungarian per Slovakian currency. The exchange rate equals one if locations  $j$  and  $k$  are in the same country.

To measure the time-series variability of the relative price, we calculate its standard deviation,  $\sigma(q_{j,k}^i)$ , where  $q_{j,k}^i = \log(Q_{j,k}^i)$ .<sup>6</sup> For the 20 products, with 190 inter-district pairs in Hungary and 630 in Slovakia, we obtain a total of 3,800 and 12,600 relative price variability observations, respectively. Similarly, for combinations of prices with mixed locations, we have 14,400 cross-country data points. The total size of the cross-section is thus 30,800 observations. In addition to product-specific relative prices, we study variability in relative prices pooled in the four product categories, and in the whole sample as well.

Table 1 gives a summary of the average standard deviations. For pairs of districts in Hungary (HH), in Slovakia (SS) and in Hungary and Slovakia (HS), we report statistics for all individual products, product categories, and the pooled sample. The first observation standing out is that while the volatility of prices is quite similar at district pairs in Hungary and in Slovakia, cross-border district pairs show much higher volatility. This pattern appears most pronounced in the pooled data with the volatility of relative prices being 0.081 in Hungary, 0.080 in Slovakia and 0.139 in cross-country district pairs. High volatility in cross-border city pairs holds for most individual products as well. It is interesting to note that the two items

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<sup>6</sup> See Engel and Rogers (1996).

exhibiting clearly distinct patterns are among the most volatile ones in Hungary, plastic bucket and movie tickets.

The figures in Table 1 also indicate that non-traded services and highly traded durable goods exhibit more volatile relative prices than the two food product categories in both countries. In light of the reasoning that internationally traded goods tend to show lower variability in relative prices, this result may first appear puzzling.<sup>7</sup> As shown in Sanyal and Jones (1982), however, higher price variation may also result from local inputs dominating the production technology of traded, or non-traded, retail items. Indeed, results in Table 1 confirm that moving from goods with large shares of non-traded inputs, labor for services and transportation for durable goods, to ones with low shares of non-traded inputs, food items made up of primarily raw materials, makes the within-country standard deviation of relative prices smaller.

## 4. Baseline Regression Results

Retail prices may differ across locations for a variety of reasons including heterogeneity in demand, taxes, transportation and other local costs. In addition, prices at locations in different countries may also deviate from each other due to exchange rate fluctuations, and other explicit and implicit costs of crossing the border. In order to explain differences in relative price variability in terms of these potential determinants, we turn to regression analysis.

As in Engel and Rogers (1996), our baseline regression equation specified separately for each product is

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<sup>7</sup> See for instance Crucini *et al* (2005) and Wolf (2003).



$$\sigma(q_{j,k,t}^i) = c + \beta_1 \ln d_{j,k} + \beta_{HS} HS + \sum_{r=1}^{N-1} \alpha_r D_r + \varepsilon_{j,k}^i,$$

where the *HS* dummy capturing the border effect equals one if the two locations *j* and *k* are in different countries, and zero otherwise. When the data pooled for the four product categories, or for the whole sample, product-specific dummies are also added. Time-invariant district-specific factors are controlled through the inclusion of district dummies,  $\sum_{r=1}^{N-1} D_r$ , where  $N = 56$ .  $D_r$  takes the value of one if  $r = j$  or  $k$ , and zero otherwise. As time-series of relative prices collapse into a single number  $\sigma(q_{j,k,t}^i)$  for each product and location-pair, the regression equation is a cross-sectional one. Economic theory dictates that relative prices are an increasing function of transportation costs, thus the  $\beta_1$  parameter is expected to be positive.<sup>8</sup> If the existence of the national border further adds to relative price variability,  $\beta_{HS}$  should take on positive a value.

For each individual good and all the pooled product categories, Table 2 presents the results in the baseline regression specification. The estimated parameters show strong evidence for the border effect, i.e. after controlling for distance and district-specific fixed effects, coefficients on the border dummy are significantly positive in all individual cases. The border is significant even for the items for which within-country volatility is exceeding cross-country volatility, suggesting that the excess volatility must stem from district-specific effects in these cases. The results in the pooled specifications also show significant coefficients on the border dummy, all with the expected sign. The results for

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<sup>8</sup> This is based on the idea that transportation costs are proportional to distance. The Appendix sets up a model developing this prediction.

distance are less pronounced. The distance parameter is significantly positive in only eight items, one group of products, and the total pooled sample.

The above findings raise the possibility that the distance function could be quadratic rather than logarithmic. Table 3 reports the results for the specification with squared distance included in the baseline regression, with distance and squared distance appearing in levels, not in logs. The figures show that the border effect in general remains significant, and that in ten individual cases the level of distance has a significantly positive and its square a significantly negative effect on relative price volatility, pointing to a concave distance-variability relationship, as predicted by the gravity model of trade.

Overall, the results suggest that national border have relatively more importance for the good-level real exchange rate volatility across locations than transportation costs, as approximated by distance do. The relationship between distance and relative prices is often concave. In addition, the distance equivalent width of the border is huge, despite the geographic proximity of locations in the two countries. Finally, the border effect is smallest for services, the least tradable product category.

## **5. What Explains the Border?**

Formal trade barriers between Hungary and Slovakia appear to be low and declining over time. Furthermore, direct physical barriers to trade between Northern Hungary and Southern Slovakia are probably lower than between some mountainous regions within Slovakia. The results above however indicate that crossing the border does add to retail price variation. How can one explain the observation that costs of arbitrage between equidistant locations appear to be larger across than within countries, when cross-country differences in economic and legal environments seem to be fairly small? In what follows, we explore three

alternative approaches to account for the border effect: language, nominal exchange rates and cross-country heterogeneity.

## **5.1. Language**

The border effect could be driven by frictions in arbitrage due to consumers being reluctant to shop in foreign stores, as they do not speak the local language. In order to investigate this hypothesis, we first split districts in Slovakia into two groups, ones with and without Hungarian serving as a second language.<sup>9</sup> Then we restrict the Slovakian part of the sample to price observations in Hungarian language districts. If cross-border relative price differentials are due to linguistic barriers, there should be *no* border effect in the restricted sample.

We estimate the baseline specification in the restricted sample. The estimation results displayed in Table 4 indicate that the coefficient estimates remain essentially unchanged.<sup>10</sup> Confirming similar findings in Engel and Rogers (1996) and Gorodnichenko and Tesar (2006), these results directly show that differences in the language spoken are not responsible for international price differentials between districts located in different countries.

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<sup>9</sup> We proxy the importance of language by the share of Hungarian minority population living in the Slovakian district. The 9 districts with considerable Hungarian minority include Dunajská Streda, Galanta, Komárno, Levice, Nové Zámky, Lučenec, Rimavská Sobota, Veľký Krtíš, and Rožňava.

<sup>10</sup> Results not reported here show that the border effect remains significant when the Slovakian sample is restricted to the remaining 27 districts. Conversely, the border effect fully disappears between the two parts of the Slovakian sample.

## 5.2. Nominal Exchange Rate Variability

The change in the international relative price, the real exchange rate, is the sum of change in the nominal exchange rate and the change in cross-location price ratios. If local wprices are rigid in the short-run, fluctuations in the real exchange rate mirror fluctuations in the nominal exchange rate.

In order to assess the importance of the nominal exchange rate in driving the wedge in volatility in international vs. intranational relative prices, we ask the question: does the border remain important when the real exchange rate is proxied by the relative real price, a variable free of fluctuations in nominal exchange rates? First, for product  $i$  in district  $j$  at time  $t$  define the real price as the local price relative to the national price level,  $P_{j,t}^i / P_t$ , where  $P_t$  is

the general price level.<sup>11</sup> Then we obtain the relative real price as  $\frac{P_{j,t}^i / P_t}{P_{k,t}^i / P_t^*}$ , where  $j$  and  $k$  are

locations in the two countries, and  $P_t$  and  $P_t^*$  are the corresponding general price indices. For

intra-national district pairs, we measure the relative real price as  $\frac{P_{j,t}^i}{P_{k,t}^i}$ , where  $j$  and  $k$  are

districts in the same country.

We focus on the regression of the standard deviation of the relative real price on log distance, border and other dummies. The results are presented in Table 5 indicate that the estimated coefficients are quite similar to the ones obtained in the baseline specification. While the border coefficient remains significant in all individual and pooled cases, the coefficient on distance, barring a few individual items as exceptions, is in general insignificant. That is, nominal exchange rates do not appear to be responsible for generating border effects.

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<sup>11</sup> See also Engel and Rogers (1996) and Gorodnichenko and Tesar (2006). We use the national price index since regional price indices are not available.

### 5.3. Country Heterogeneity

In a recent paper, Gorodnichenko and Tesar (2006) argue that the baseline specification in Engel and Rogers (1996) results in a biased estimate of the border effect, as it confounds the true effect with the impact of within-country heterogeneity in relative prices. To correct for the bias, they suggest augmenting the regression equation with a dummy variable capturing country specific effects in relative price variability as

$$\sigma(q_{j,k,t}^i) = c + \beta_1 \ln d_{j,k} + \beta_2 \text{Border}_{HS} + \beta_3 \text{Border}_{SS} + \phi_i + \alpha_j + \alpha_k + \varepsilon_{j,k}^i.$$

In this specification, the only new variable relative to the baseline one is the  $\text{Border}_{SS}$  dummy representing price pairs taken only from Slovakia. Here the parameter  $\beta_2$  captures the increase in relative price variation at a Hungarian-Slovakian price pair, relative to a Hungarian-Hungarian one. Similarly,  $\beta_2 - \beta_3$  captures the increase in relative price variation at a Hungarian-Slovakian price pair, relative to a Slovakian-Slovakian one. Notice that if  $\beta_3$  is small, the bias induced by within-country heterogeneity in border estimates is negligible, and the direction from which the border is crossed is inconsequential in quantifying the border effect.

We estimate the above regression equation by Restricted Least Squares, under the restriction that the average district dummies sum to zero within the two countries. First, the results reported in Table 6 show that the cross-border dummy is significant in all but one of the cases. A comparison to the results in Table 1 also indicates that the two products where the sign of the border coefficient is negative, plastic bucket and movie ticket are instances in which the within-country relative price variability exceeds the cross-country one. Second, while the dummy attached to the Slovakian district-pairs is also significant for most individual products, with mixed signs, it is not significantly different from zero in the full pooled sample

and in two of the four pooled product groups. Furthermore, albeit the coefficient is significant in the group of other food products, it is numerically small. These findings square well with the observation documented in Table 1, that the smallest differences in within-country variability appear in the meat products and the services product groups, or when all products in the full sample are pooled together. Finally, for a number of individual products where the Slovakian district-pair dummy is different from zero, especially in the meat and other food product categories, the within-country dummy coefficient is numerically small relative to the cross-country one, rendering the cross-country heterogeneity induced bias in the estimated border effect quantitatively unimportant.

## 6. Conclusions

Using retail prices of 20 individual homogenous items grouped into four product categories (durable goods, meat products, other food products and services) observed at 20 locations in Hungary and 36 locations in Slovakia over a period of 56 months, this study estimated the border effect in two small, neighboring, open economies, Hungary and Slovakia. The main advantage of our empirical approach is the focus on an episode where locations are geographically close to each other, international trade barriers are relatively small and vanishing, the physical characteristics of goods and services are homogeneous over time and across locations, and within-country relative price variability is about the same in the two countries.

The overriding message of the paper is that the border *does* matter. That is, in various specifications based on, and extending the one in Engel and Rogers (1996), we find that that the national border has an independent, sizeable, statistically significant impact on relative price variability. At the same time, the impact of transportation costs as proxied by distance between locations is much less pronounced. These results are robust to accounting for

nominal exchange rate variability, differences in local culture as represented by language spoken and cross-country heterogeneity in relative price variability.

## Appendix

Define  $T_{j,k,t}^i$  as the cost of trade between location  $j$  and  $k$ , per unit of good  $i$  in time period  $t$ .<sup>12</sup> Assume symmetry, i.e. going from  $j$  to  $k$  costs the same as from  $k$  to  $j$ . We posit that the law of one price applies so that the price ratios adjusted by the nominal exchange, the relative price (that is, the real exchange rate), cannot exceed the corresponding cost of trade between two locations:  $\frac{1}{T_{j,k,t}^i} \leq Q_{j,k,t}^i \leq T_{j,k,t}^i$ . After taking logs, and assuming time-invariant trade costs, we obtain  $-t_{j,k}^i \leq q_{j,k,t}^i \leq t_{j,k}^i$ . That is, if the relative price lies inside the interval of  $[-t_{j,k}^i, t_{j,k}^i]$ , there is no incentive for arbitrage trade.<sup>13</sup>

Assume that the cost of trade takes the form of

$T_{j,k}^i = e^{c + \beta_1 \ln d_{j,k} + \beta_2 \text{Border} + \phi_i + \alpha_j + \alpha_k + \varepsilon_{j,k}^i}$ , where  $c$  is a constant,  $d_{j,k}$  is the distance between locations  $j$  and  $k$ ; *border* represents costs arising when trade occurs between locations separated by a border;  $\phi_i$  is the cost of trade specific to good  $i$ ,  $\alpha_j$  and  $\alpha_k$  are the cost of trade specific to locations  $j$  and  $k$ , respectively, and the last term is a residual. Also assume that  $q_{j,k,t}^i$  follows a random walk inside the inaction region. It then follows that the standard deviation of  $q_{j,k,t}^i$  is proportional to the log of trade costs,

$$\sigma(q_{j,k,t}^i) \approx \ln T_{j,k}^i = c + \beta_1 \ln d_{j,k} + \beta_2 \text{Border} + \phi_i + \alpha_j + \alpha_k + \varepsilon_{j,k}^i.$$

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<sup>12</sup> See Gorodnichenko and Tesar (2006).

<sup>13</sup> Trade costs include transportation costs, tariffs, informational costs, contract enforcement costs, costs due to different currencies used, legal and regulatory costs, local distributional costs, and other costs. There could also be various impediments to arbitrage by wholesalers. See Anderson and van Wincoop (2004).



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**Table 1**  
Relative Price Volatility

Product Number	Product Name	HH	SS	HS
<b>Durable Goods</b>				
1	White Lime	0.082	0.059	<b>0.104</b>
2	Turkish Towel	0.102	0.098	<b>0.103</b>
3	Plastic Bucket	<b>0.120</b>	0.075	0.113
4	Drawing Paper, A4 Size	0.096	0.097	<b>0.112</b>
5	Basic Pocket Calculator	0.122	0.143	<b>0.172</b>
<b>Meat Products</b>				
6	Beef Round	0.055	0.045	<b>0.090</b>
7	Pork Chops	0.045	0.042	<b>0.151</b>
8	Pork Leg without Bone and Hoof	0.045	0.049	<b>0.156</b>
9	Spare Ribs with Bone	0.045	0.046	<b>0.152</b>
10	Pork Liver	0.056	0.058	<b>0.100</b>
11	Smoked Boiled Bacon	0.089	0.094	<b>0.144</b>
12	Lard, Pork	0.132	0.120	<b>0.249</b>
<b>Other Food Products</b>				
13	Poppy Seed	0.120	0.145	<b>0.171</b>
14	Sugar, White, Granulated	0.029	0.052	<b>0.084</b>
15	Flour, Prime Quality	0.064	0.056	<b>0.184</b>
16	Raisins	0.084	0.078	<b>0.100</b>
17	Vinegar	0.073	0.072	<b>0.176</b>
18	Dry Biscuits, without Butter	0.066	0.067	<b>0.091</b>
<b>Services</b>				
19	Car Driving School, Full Course	0.080	0.114	<b>0.208</b>
20	Movie Ticket, Evening, 1-6 Rows	<b>0.120</b>	0.090	0.117
1-5	Durable Goods Average	0.104	0.094	<b>0.121</b>
6-12	Meat Products Average	0.066	0.065	<b>0.149</b>
13-18	Other Food Products Average	0.073	0.078	<b>0.134</b>
19-20	Services Average	0.100	0.102	<b>0.163</b>
1-20	Total Average	0.081	0.080	<b>0.139</b>
Number of Observations		190	630	720

Entries give the average volatility across all pairs of counties within Hungary (HH), within Slovakia (SS), and across the Hungarian-Slovakian border (HS), respectively. The measure of volatility is the standard deviation of the relative price. The sample period is 1997:05-2001:12. Bold figures show the largest value in the three groups.

**Table 2**  
Baseline Regression

Product Number	Product Name	Border	Distance	Adjusted R <sup>2</sup>
1	White Lime	<b>3.083</b> (0.101)	<b>0.570</b> (0.093)	0.721
2	Turkish Towel	<b>0.360</b> (0.135)	-0.058 (0.115)	0.667
3	Plastic Bucket	<b>1.566</b> (0.137)	-0.052 (0.115)	0.713
4	Drawing Paper, A4 Size	<b>1.593</b> (0.163)	-0.132 (0.140)	0.476
5	Basic Pocket Calculator	<b>4.072</b> (0.280)	-0.253 (0.238)	0.456
6	Beef Round	<b>3.929</b> (0.066)	<b>0.145</b> (0.066)	0.844
7	Pork Chops	<b>10.780</b> (0.051)	0.027 (0.044)	0.977
8	Pork Leg without Bone and Hoof	<b>10.895</b> (0.064)	0.057 (0.055)	0.964
9	Spare Ribs with Bone	<b>10.462</b> (0.055)	<b>0.264</b> (0.047)	0.972
10	Pork Liver	<b>4.202</b> (0.081)	<b>0.166</b> (0.069)	0.773
11	Smoked Boiled Bacon	<b>5.459</b> (0.126)	0.033 (0.107)	0.790
12	Lard, Pork	<b>12.385</b> (0.183)	-0.100 (0.156)	0.854
13	Poppy Seed	<b>3.525</b> (0.160)	<b>0.612</b> (0.136)	0.589
14	Sugar, White, Granulated	<b>4.215</b> (0.047)	<b>0.280</b> (0.040)	0.897
15	Flour, Prime Quality	<b>12.302</b> (0.092)	<b>0.194</b> (0.078)	0.947
16	Raisins	<b>1.896</b> (0.098)	-0.014 (0.083)	0.599
17	Vinegar	<b>10.233</b> (0.105)	0.159 (0.090)	0.911
18	Dry Biscuits, without Butter	<b>2.441</b> (0.084)	0.032 (0.071)	0.870
19	Car Driving School, Full Course	<b>10.917</b> (0.245)	<b>0.451</b> (0.208)	0.735
20	Movie Ticket, Evening, 1-6 Rows	<b>1.088</b> (0.130)	<b>0.268</b> (0.110)	0.750
1-5	Group Average	<b>2.135</b> (0.125)	0.015 (0.107)	0.164
6-12	Group Average	<b>8.302</b> (0.106)	0.085 (0.090)	0.469
13-18	Group Average	<b>5.769</b> (0.113)	<b>0.210</b> (0.096)	0.308
19-20	Group Average	<b>6.003</b> (0.229)	0.359 (0.195)	0.391
1-20	Total Average	<b>5.770</b> (0.069)	<b>0.132</b> (0.058)	0.268

Standard errors are in paranthesis. To ease exposition, the border and distance parameters, and the corresponding standard errors, are multiplied by 100. All regressions contain a constant term and city dummies. Bold figures indicate statistical significance at the 5 percent level.

**Table 3**  
Quadratic Specification

Product Number	Product Name	Border	Distance	Distance Square	Adjusted R <sup>2</sup>
1	White Lime	<b>3.084</b> (0.115)	<b>5.829</b> (1.534)	<b>-5.965</b> (2.787)	0.721
2	Turkish Towel	0.261 (0.140)	-1.860 (1.895)	<b>6.707</b> (3.395)	0.668
3	Plastic Bucket	<b>1.533</b> (0.142)	-1.860 (1.896)	3.469 (3.433)	0.713
4	Drawing Paper, A4 Size	<b>1.639</b> (0.172)	-0.576 (2.293)	0.777 (4.163)	0.475
5	Basic Pocket Calculator	<b>4.130</b> (0.291)	2.350 (3.878)	1.691 (7.045)	0.456
6	Beef Round	<b>3.933</b> (0.069)	<b>4.655</b> (0.912)	<b>-8.305</b> (1.669)	0.846
7	Pork Chops	<b>10.870</b> (0.053)	<b>3.495</b> (0.711)	<b>-7.586</b> (1.293)	0.977
8	Pork Leg without Bone and Hoof	<b>10.982</b> (0.067)	<b>3.476</b> (0.898)	<b>-7.275</b> (1.631)	0.964
9	Spare Ribs with Bone	<b>10.522</b> (0.057)	<b>5.230</b> (0.769)	<b>-8.326</b> (1.397)	0.972
10	Pork Liver	<b>4.290</b> (0.085)	<b>5.707</b> (1.129)	<b>-10.440</b> (2.052)	0.776
11	Smoked Boiled Bacon	<b>5.565</b> (0.133)	2.868 (1.768)	<b>-6.670</b> (3.212)	0.791
12	Lard, Pork	<b>12.729</b> (0.190)	<b>13.137</b> (2.533)	<b>-30.259</b> (4.602)	0.859
13	Poppy Seed	<b>3.405</b> (0.168)	1.804 (2.239)	3.657 (4.067)	0.591
14	Sugar, White, Granulated	<b>4.212</b> (0.049)	<b>2.703</b> (0.654)	<b>-2.583</b> (1.189)	0.897
15	Flour, Prime Quality	<b>12.352</b> (0.097)	<b>4.067</b> (1.289)	<b>-6.605</b> (2.342)	0.947
16	Raisins	<b>1.893</b> (0.103)	-0.347 (1.378)	0.559 (2.504)	0.599
17	Vinegar	<b>10.215</b> (0.111)	-0.305 (1.480)	2.118 (2.688)	0.911
18	Dry Biscuits, without Butter	<b>2.428</b> (0.088)	-0.309 (1.173)	1.019 (2.132)	0.870
19	Car Driving School, Full Course	<b>11.263</b> (0.255)	<b>19.592</b> (3.402)	<b>-37.493</b> (6.178)	0.741
20	Movie Ticket, Evening, 1-6 Rows	<b>0.986</b> (0.136)	-1.420 (1.818)	<b>6.420</b> (3.302)	0.751
1-5	Group Average	<b>2.125</b> (0.130)	-0.406 (1.735)	1.025 (3.151)	0.164
6-12	Group Average	<b>8.422</b> (0.110)	<b>5.510</b> (1.469)	<b>-11.266</b> (2.668)	0.470
13-18	Group Average	<b>5.751</b> (0.118)	1.269 (1.564)	-0.306 (2.841)	0.308
19-20	Group Average	<b>6.125</b> (0.238)	<b>9.086</b> (3.167)	<b>-15.536</b> (5.753)	0.392
1-20	Total Average	<b>5.817</b> (0.071)	<b>3.116</b> (0.948)	<b>-5.332</b> (1.722)	0.268

Distance and squared distance are in levels here, not in logs. To ease exposition, the border parameter is multiplied by 100, the distance and the squared distance parameters by 100,000. See also notes to Table 2.

**Table 4**  
Language

Product Number	Product Name	Border	Distance	Adjusted R <sup>2</sup>
1	White Lime	<b>0.998</b> (0.189)	-0.073 (0.380)	0.660
2	Turkish Towel	<b>1.080</b> (0.266)	-0.159 (0.535)	0.696
3	Plastic Bucket	<b>2.738</b> (0.373)	-0.751 (0.751)	0.514
4	Drawing Paper, A4 Size	<b>2.601</b> (0.276)	0.238 (0.555)	0.507
5	Basic Pocket Calculator	<b>4.245</b> (0.445)	0.479 (0.896)	0.694
6	Beef Round	<b>5.393</b> (0.152)	<b>1.048</b> (0.306)	0.855
7	Pork Chops	<b>12.482</b> (0.111)	<b>0.502</b> (0.223)	0.981
8	Pork Leg without Bone and Hoof	<b>12.323</b> (0.122)	0.481 (0.245)	0.977
9	Spare Ribs with Bone	<b>11.975</b> (0.125)	<b>0.656</b> (0.252)	0.975
10	Pork Liver	<b>5.877</b> (0.153)	<b>1.106</b> (0.308)	0.881
11	Smoked Boiled Bacon	<b>8.986</b> (0.275)	-0.705 (0.553)	0.851
12	Lard, Pork	<b>16.629</b> (0.428)	0.984 (0.862)	0.855
13	Poppy Seed	<b>1.443</b> (0.327)	<b>1.676</b> (0.658)	0.528
14	Sugar, White, Granulated	<b>4.060</b> (0.070)	<b>0.303</b> (0.141)	0.953
15	Flour, Prime Quality	<b>13.447</b> (0.190)	0.217 (0.382)	0.952
16	Raisins	4.679 (0.238)	-0.664 (0.478)	0.709
17	Vinegar	<b>10.132</b> (0.198)	0.506 (0.398)	0.919
18	Dry Biscuits, without Butter	<b>5.951</b> (0.161)	0.399 (0.323)	0.887
19	Car Driving School, Full Course	<b>7.701</b> (0.404)	-0.292 (0.813)	0.718
20	Movie Ticket, Evening, 1-6 Rows	<b>0.657</b> (0.286)	1.028 (0.576)	0.747
1-5	Group Average	<b>2.332</b> (0.246)	-0.053 (0.494)	0.178
6-12	Group Average	<b>10.523</b> (0.222)	0.582 (0.448)	0.558
13-18	Group Average	<b>6.619</b> (0.205)	0.406 (0.412)	0.436
19-20	Group Average	<b>4.179</b> (0.395)	0.368 (0.795)	0.306
1-20	Total Average	<b>6.670</b> (0.137)	0.349 (0.275)	0.316

See notes to Table 2.

**Table 5**  
Nominal Exchange Rate

Product Number	Product Name	Border	Distance	Adjusted R <sup>2</sup>
1	White Lime	<b>1.090</b> (0.097)	<b>0.514</b> (0.083)	0.652
2	Turkish Towel	<b>1.528</b> (0.148)	-0.001 (0.126)	0.631
3	Plastic Bucket	<b>3.611</b> (0.162)	-0.008 (0.138)	0.688
4	Drawing Paper, A4 Size	<b>1.636</b> (0.152)	0.075 (0.129)	0.524
5	Basic Pocket Calculator	<b>2.725</b> (0.249)	-0.213 (0.212)	0.513
6	Beef Round	<b>5.267</b> (0.069)	<b>0.153</b> (0.059)	0.881
7	Pork Chops	<b>12.655</b> (0.053)	0.060 (0.045)	0.982
8	Pork Leg without Bone and Hoof	<b>12.665</b> (0.064)	0.070 (0.055)	0.974
9	Spare Ribs with Bone	<b>12.153</b> (0.056)	<b>0.291</b> (0.048)	0.979
10	Pork Liver	<b>5.995</b> (0.077)	<b>0.175</b> (0.065)	0.875
11	Smoked Boiled Bacon	<b>9.276</b> (0.138)	0.009 (0.117)	0.856
12	Lard, Pork	<b>15.381</b> (0.196)	-0.083 (0.166)	0.881
13	Poppy Seed	<b>2.550</b> (0.150)	<b>0.422</b> (0.127)	0.561
14	Sugar, White, Granulated	<b>4.296</b> (0.056)	<b>0.329</b> (0.048)	0.854
15	Flour, Prime Quality	<b>13.722</b> (0.090)	<b>0.206</b> (0.077)	0.959
16	Raisins	<b>4.707</b> (0.119)	-0.085 (0.101)	0.707
17	Vinegar	<b>11.079</b> (0.095)	<b>0.168</b> (0.080)	0.937
18	Dry Biscuits, without Butter	<b>5.320</b> (0.101)	0.034 (0.086)	0.876
19	Car Driving School, Full Course	<b>8.477</b> (0.228)	<b>0.439</b> (0.194)	0.718
20	Movie Ticket, Evening, 1-6 Rows	<b>1.181</b> (0.124)	<b>0.369</b> (0.105)	0.782
1-5	Group Average	<b>2.118</b> (0.122)	0.073 (0.104)	0.176
6-12	Group Average	<b>10.484</b> (0.112)	0.096 (0.095)	0.553
13-18	Group Average	<b>6.946</b> (0.108)	0.179 (0.092)	0.404
19-20	Group Average	<b>4.829</b> (0.200)	<b>0.404</b> (0.170)	0.425

1-20	Total Average	<b>6.766</b> (0.069)	<b>0.146</b> (0.059)	0.328
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See notes to Table 2.



**Table 6**  
Country Heterogeneity

Product Number	Product Name	Border <sub>SS</sub>	Border <sub>HS</sub>	Distance	Adjusted R <sup>2</sup>
1	White Lime	<b>-2.239</b> (0.151)	<b>1.963</b> (0.151)	<b>0.570</b> (0.094)	0.722
2	Turkish Towel	<b>-0.493</b> (0.185)	0.114 (0.185)	-0.058 (0.115)	0.668
3	Plastic Bucket	<b>-4.476</b> (0.187)	<b>-0.672</b> (0.187)	-0.052 (0.116)	0.713
4	Drawing Paper, A4 Size	0.074 (0.226)	<b>1.631</b> (0.227)	-0.132 (0.141)	0.476
5	Basic Pocket Calculator	<b>2.022</b> (0.382)	<b>5.083</b> (0.383)	-0.253 (0.238)	0.456
6	Beef Round	<b>-1.005</b> (0.091)	<b>3.426</b> (0.091)	<b>0.145</b> (0.057)	0.844
7	Pork Chops	<b>-0.270</b> (0.071)	<b>10.645</b> (0.071)	0.027 (0.044)	0.977
8	Pork Leg without Bone and Hoof	<b>0.340</b> (0.089)	<b>11.065</b> (0.089)	0.057 (0.056)	0.964
9	Spare Ribs with Bone	<b>0.219</b> (0.076)	<b>10.572</b> (0.076)	<b>0.264</b> (0.048)	0.972
10	Pork Liver	0.204 (0.112)	<b>4.304</b> (0.112)	<b>0.166</b> (0.070)	0.773
11	Smoked Boiled Bacon	<b>0.947</b> (0.175)	<b>5.933</b> (0.175)	0.033 (0.109)	0.790
12	Lard, Pork	<b>-1.258</b> (0.254)	<b>11.756</b> (0.255)	-0.100 (0.158)	0.854
13	Poppy Seed	<b>2.694</b> (0.221)	<b>4.872</b> (0.222)	<b>0.612</b> (0.138)	0.589
14	Sugar, White, Granulated	<b>2.411</b> (0.064)	<b>5.420</b> (0.065)	<b>0.280</b> (0.040)	0.897
15	Flour, Prime Quality	<b>-0.794</b> (0.127)	<b>11.905</b> (0.127)	<b>0.194</b> (0.079)	0.947
16	Raisins	<b>-0.634</b> (0.136)	<b>1.579</b> (0.136)	-0.014 (0.085)	0.599
17	Vinegar	-0.033 (0.146)	<b>10.217</b> (0.146)	0.159 (0.091)	0.912
18	Dry Biscuits, without Butter	0.096 (0.116)	<b>2.489</b> (0.116)	0.032 (0.072)	0.870
19	Car Driving School, Full Course	<b>3.506</b> (0.339)	<b>12.671</b> (0.339)	<b>0.451</b> (0.211)	0.736
20	Movie Ticket, Evening, 1-6 Rows	<b>-2.954</b> (0.180)	<b>-0.389</b> (0.180)	<b>0.268</b> (0.112)	0.750
1-5	Group Average	<b>-1.022</b> (0.171)	<b>1.624</b> (0.171)	0.015 (0.107)	0.164
6-12	Group Average	-0.118 (0.145)	<b>8.243</b> (0.145)	0.085 (0.090)	0.469
13-18	Group Average	<b>0.623</b> (0.154)	<b>6.080</b> (0.154)	<b>0.210</b> (0.096)	0.308
19-20	Group Average	0.276 (0.312)	<b>6.141</b> (0.313)	0.360 (0.195)	0.391
1-20	Total Average	-0.082 (0.094)	<b>5.729</b> (0.094)	<b>0.132</b> (0.058)	0.268

See notes to Table 2.