Beyond Borders: Unveiling the Impact of Product Variety

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Abstract

Border effects on prices are complex. This study reveals a hidden factor: vast differences in product variety across regions, even between stores. Borders make price convergence of traded products difficult between markets and create local products within markets. We show that local products reinforce the effect of borders increasing its effect. Lastly, we provide a way to account for local products in the estimation of borders.

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1 Introduction

Borders between regions or countries have been one of the most extended explanations for the non-convergence of prices in the trade literature (Engel and Rogers, 1996, Anderson and van Wincoop, 2001, McCallum, 1995, Parsley and Wei, 2001, Gorodnichenko and Tesar, 2009; and more recently Gopinath, Gourinchas, Hsieh, and Li, 2011, Beck, Kotz, and Zabelina, 2020, and Messner, Rumler, and Strasser, 2023). Also, trade costs play a significant role in explaining how goods are traded between different markets (Anderson and van Wincoop, 2003, Anderson and van Wincoop, 2004, and Atkin and Donaldson, 2015). Other explanations for price divergence include the existence of high fixed costs of production for some goods (Coşar, Grieco, and Tintelnot, 2015b, Coşar, Grieco, and Tintelnot, 2015a), price discrimination of consumers (Haskel and Wolf, 2001, Dvir and Strasser, 2018), a different currency (Cavallo, Neiman, and Rigobon, 2015), or—within countries—sticky prices (see Crucini, Shintani, and Tsuruga, 2010, Elberg, 2016).

Geographical regions also differ in income and consumer preferences for products. For example, Bronnenberg, Dube, and Gentzkow, 2012 showed that preferences are geographically based and time persistent. In such settings, stores may offer different varieties or brands of similar products. Differences between products may include size, flavor, brand, etc. Interestingly, the evidence shows that most retail products are not traded. For example, Broda and Weinstein (2008) established that in "the typical bilateral city/region comparison between the US and Canada only 7.5 percent of the goods are common" (page 11), Gopinath, Gourinchas, Hsieh, and Li (2011) found 4,221 everyday products out of 125,048 unique products (i.e., 3.4 percent) for the same countries. More recently, Messner, Rumler, and Strasser (2023) analyzing transactions at the border between Austria and Germany establishes that "once we restrict the sample to products sold on both sides of the border, we are left with a tenth of products..." (page 8).[1]

While some products are traded, most are sold only in local markets. Borders explain how the prices of traded goods differ and how they prevent local products from being traded. Traded brands compete with each other between markets, but also with local brands within markets. In Borraz and Zipitría (2022), we showed that variety differences explain why prices diverge between regions. Cavallo, Feenstra, and Inklaar (2023) show how differences in varieties impact the cost of living between countries, and Handbury and Weinstein (2015) showed how they bias the estimation of price indexes in the US.

This paper presents an extension of Borraz and Zipitría (2022) to include borders. Borders affect price convergence between traded goods and also create local goods. In turn, local goods compete with traded goods affecting their price convergence. We show that both reinforce each other, further increasing the divergence of prices. Our paper also helps explain why price divergence between countries is much higher than within

[1] See also Beck, Kotz, and Zabelina (2020) Table 1 for matched products between countries.

countries; in the first case, both effects are at work and reinforced.

2 The Border Effect

We assume a linear city model with two stores and a continuum of consumers in a road of distance L. Consumer located at j has utility $U_j = r - t\,|x_j - x_d| - p_d$, where t is the cost per unit of distance to the store located at d. Stores are located at $d = \{0, L\}$, i.e., at the beginning and end of the road, denoted $\{S_0, S_L\}$ respectively. Assume also that costs are zero. In this symmetric setting, prices are tL, and there is no price dispersion between stores. Denote the indifferent consumer from buying the same product between the two stores is $\widehat{x}$.

We introduce a cost for the consumer to cross a hypothetical border between stores.[2] We assume the border is at some place b between both stores. The border implies a fixed cost of β for consumers who cross it to buy from a store on the other side. The utility is now $U_j = r - t\,|x_j - x_d| - \beta \times \mathbb{1}\{c_j \neq c_d\} - p_d$, where $\mathbb{1}\{c_j \neq c_d\}$ is an indicator function that equal one if the country of the consumer c_j and the store c_d differ, and 0 otherwise. With a positive border cost, the indifferent consumer shifts from $\widehat{x}$ to x^b. If both are in the same place, then the border does not play any role. The next Lemma shows this result.

Lemma 1. *If the border is where the indifferent consumer is, then the border cost is irrelevant.*

Proof. Assume two consumers, each located at a small ε distance to the border x^b. As the consumer at the left of x^b prefers to buy at S_0, then it must be that $r - t\left(x^b - \varepsilon\right) - p_0 > r - t\left[L - \left(x^b - \varepsilon\right)\right] - p_L + \beta$, and solving for $\left(x^b - \varepsilon\right)$ we obtain $\left(x^b - \varepsilon\right) > \frac{p_L - p_0 + tL}{2t} - \frac{\beta}{2t}$. For the consumer located at the right, as she prefers S_L to S_0 his utility must be such as $r - t\left(x^b + \varepsilon\right) - p_0 + \beta < r - t\left[L - \left(x^b - \varepsilon\right)\right] - p_L$, and solving for $\left(x^b + \varepsilon\right)$ we obtain $\left(x^b + \varepsilon\right) < \frac{p_L - p_0 + tL}{2t} + \frac{\beta}{2t}$. As $\varepsilon \to 0$, we obtain $\frac{p_L - p_0 + tL}{2t} - \frac{\beta}{2t} < x^b < \frac{p_L - p_0 + tL}{2t} + \frac{\beta}{2t}$. Then, $x^b = \frac{p_L - p_0 + tL}{2t}$. □

Lemma 1 says that the border binds only if it shifts consumers from buying from one store to the other. Consumers at the right of the border already prefer to buy at S_L, and those at the left choose to buy at S_0. Assume that the border is to the right of $\widehat{x}$, the indifferent consumer when no border exists. Now, some consumers who otherwise would have bought at S_L will buy at S_0 due to the border costs. Nevertheless, consumers at the right of the border will continue buying at S_L, as they already prefer that store, and the border cost does not affect their decision. How many consumers will switch from store S_L to S_0 will depend on the magnitude of the cost β.

[2] A similar assumption is made in Gopinath, Gourinchas, Hsieh, and Li (2011).

For every positive border cost β, the indifferent consumer should move from $\widehat{x}$ through x^b. The new indifferent consumer x^b should be at $\widehat{x}+\beta$, as the utility is linear in cost. As a result, $x^b = \widehat{x} + \beta = \frac{p_L - p_0 + tL}{2t} + \beta$, where $\beta \in [0, (b - \widehat{x})]$. If β is larger than $\left(x^b - \widehat{x}\right)$, then Lemma 1 establishes that the demand for store S_0 should be x^b. The demand for store S_0 is $D_0 = \frac{p_L - p_0 + tL + 2t\beta}{2t}$, and the reaction function is $p_0 = \frac{p_L + Lt + 2t\beta}{2}$. Demand for store S_L is $D_L = \frac{p_0 - p_L + tL - 2t\beta}{2t}$, and the reaction function for price p_L is $p_L = \frac{p_0 + Lt - 2t\beta}{2}$. The equilibrium prices are $p_0^b = tL + \frac{2t\beta}{3}$ and $p_L^b = tL - \frac{2t\beta}{3}$. Our second Lemma follows.

Lemma 2. *Borders make price convergence less likely.*

Proof. Now $p_{A0}^b - p_{AL}^b = \frac{4}{3}t\beta$. $\square$

If x^b is at the left of $\widehat{x}$ instead, then the prices p_0^b and p_L^b reverse. We now compute the size of the border by substituting p_0^b and p_L^b in $x^b = \widehat{x} + \beta = \frac{5}{3}\beta + \frac{L}{2}$. As $x^b \in \left[\frac{L}{2}, L\right]$, then $\beta \in \left[0, \frac{3}{10}L\right]$.

Because borders shift demand, prices change with borders, and price convergence becomes more difficult. In the example, as the border is at the right of $\widehat{x}$, consumers at the left of the border cannot buy at store S_L. Then, store S_0 increases its prices, as the border allows it to increase its market power, while the reverse is true to store S_L.

3 Variety and Border

Section 1 showed that countries differ in the varieties of goods offered to consumers. Borders do not just prevent the prices of international brands from converging; they also prevent local brands from being sold in other countries. Traded brands must deal with different local brands between countries, i.e., different competition. What happens when a traded brand—the one sold in both countries—has to compete with a local brand? Following Borraz and Zipitría (2022), we incorporate this asymmetry between countries by adding to our model a product—variety—sold only in one store. This simple setting allows us to show how price convergence is affected when local brands or varieties are available in different markets and how it affects the estimation of the effect of the border.

At each point in the line, there are now two types of consumers who differ in their preference for varieties $z_i = \{z_A, z_B\}$. While the distance dimension is continuous, variety is discrete. Furthermore, a mass $(1 - \lambda)$ of consumers prefer variety z_A, and a mass λ of consumers prefer variety z_B. The model could be represented as two lines of distance L, one on top of the other.[3] Stores could offer varieties s_q, with $q = \{A, B\}$, and assume that variety A is available at both stores, the traded one, but variety B is sold only at the store located at S_0, the local one. That is, we are imposing some brand asymmetry

[3] See Borraz and Zipitría (2022) figure 2.

between stores that affect the local pricing decisions of products on both sides of the border, in line with the literature of Section 1.

The consumer utility is now:

$$U_{ij} = r - \theta \times \mathbb{1}\{z_i \neq s_q\} - t\,|x_j - x_d| - \beta \times \mathbb{1}\{c_j \neq c_d\} - p_{qd},$$

where j is for the consumer's location and i is for its brand preference, θ is a fixed cost the consumer pays if the brand available s_q is different and is not her preferred one (z_i). The utility function has three costs on consumer utility: one that lowers his utility if his preferred variety is unavailable (θ), one that taxes her for buying in another country (β), and a transport cost for reaching the store.

In Borraz and Zipitría (2022), if there is no border (i.e., $\beta = 0$), we found that the price of the traded product is $p_{A0} = tL - \frac{\delta\theta}{6}$ and $p_{AL} = tL - \frac{\delta\theta}{3}$, and prices do not converge due to different competitive conditions at the store. Also, in this setting, there are two indifferent consumers: the "location" consumer, who is indifferent between buying the traded product in either store/country ($\widehat{x}$), and the "variety" consumer, who is indifferent between buying at S_0 the B local product instead of reaching store S_L and buying the A non-preferred traded variety (x^v).[4] We also showed that the indifferent consumer for variety (x^v) should be at the right of the indifferent consumer for location ($\widehat{x}$). The intuition is simple. The indifferent consumer for local products has two penalties: one for buying the—non-preferred—traded brand and another for moving to another store. Then, compared to consumers who only need to move to the other store to buy their preferred variety, a larger number of those who switch variety consumers will stick to their preferred brand because it is unavailable at the other store. Assume that the border is far to the right from both indifferent consumers. Figure 1 below depicts the setting.

We assume the border b is at the right of x^v and $\widehat{x}$.[5] As $\widehat{x} \neq x^v$, the effect of the border will be different for the consumers of a variety A than for consumers of a variety B.

The indifferent "location" consumer $\widehat{x}'$, the one that prefers the traded brand, has utility: $r - t\,|\widehat{x} - 0| - p_{A0} = r - t\,|\widehat{x} - L| - p_{AL} - \beta$, then $\widehat{x}' = \widehat{x} + \widehat{\beta} = \frac{p_{AL} - p_{A0} + tL}{2t} + \widehat{\beta}$. The indifferent "variety" consumer $x^{b\prime}$, the one that switches brands and stores, has utility: $r - t\,|\widehat{x} - 0| - p_{B0} = r - t\,|\widehat{x} - L| - p_{AL} - \theta - \beta$, then $x^{b\prime} = x^b + \beta^b = \frac{p_{AL} - p_{B0} + tL + \theta}{2t} + \beta^b$, where $\widehat{\beta} \in [0,\, (b - \widehat{x})]$ and $\beta^b \in \left[0,\, \left(b - x^b\right)\right]$ and $\beta^b \leq \widehat{\beta}$.[6] The border coefficient will be subtracted if the border b is at the left of $\widehat{x}$.

Store S_0 sells varieties A and B , so its profits are $\pi_0 = p_{A0} \times \lambda \widehat{x}' + p_{B0} \times (1 - \lambda) x^{b\prime}$ $= p_{A0} \times \lambda(\frac{p_{AL} - p_{A0} + tL}{2t} + \widehat{\beta}) + p_{B0} \times (1 - \lambda)(\frac{p_{AL} - p_{B0} + tL + \theta}{2t} + \beta^b)$. Maximizing in p_{A0} and

[4](Borraz and Zipitría, 2022) call the second indifferent consumer $\widetilde{x}$.

[5]The case where b is between both $\widehat{x}$ and x^b cancel out.

[6]The inequality is reversed if the border b is at the left of $\widehat{x}$.

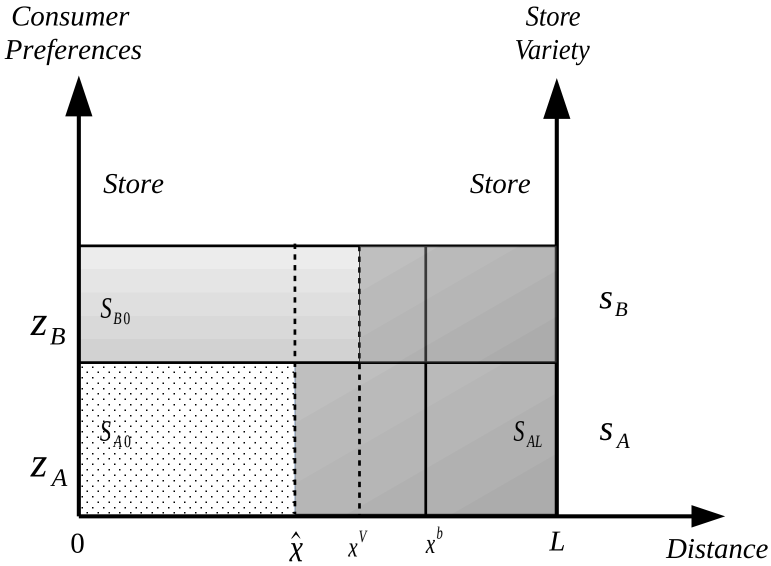

Figure 1: A Linear City with Varieties and Border.

p_{B0} we obtain $p_{A0} = \frac{p_{AL}+Lt+2t\widehat{\beta}}{2}$ and $p_{B0} = \frac{p_{AL}+tL+\theta+2t\beta^b}{2}$.

Store S_L sells only variety A to both consumers, so its profits are $\pi_L = p_{AL} \times \left[(1-\lambda) \times (L-\widehat{x}') + \lambda \times (L - x^{b\prime})\right]$
$= p_{AL} \times \left[(1-\lambda)(L - (\frac{p_{AL}-p_{A0}+tL}{2t} + \widehat{\beta})) + \lambda(L - (\frac{p_{AL}-p_{B0}+tL+\theta}{2t} + \beta^b))\right]$. Maximizing in p_{AL} we obtain $p_{AL} = \frac{(1-\lambda)p_{A0}+\lambda p_{B0}+Lt-\lambda\theta-2t\left[\widehat{\beta}+\lambda\left(\beta^b-\widehat{\beta}\right)\right]}{2}$.

Substituting reaction functions, we obtain:

$$p_{A0}^{bv} = tL - \frac{\lambda\theta}{6} + \frac{t\left[2\widehat{\beta} + \lambda\left(\widehat{\beta} - \beta^b\right)\right]}{3},$$

$$p_{AL}^{bv} = tL - \frac{\lambda\theta}{3} - \frac{2t\left[\widehat{\beta} - \lambda\left(\widehat{\beta} - \beta^b\right)\right]}{3}.$$

For completion, $p_{B0}^{bv} = Lt + \frac{(3-\lambda)\theta}{6} + \frac{t\left[(3-\lambda)\widetilde{b}-(1-\lambda)\widehat{b}\right]}{3}$. Our third Lemma follows.

Lemma 3. *Differences in varieties between stores reinforce the effect of the border.*

Proof. Price difference is now $p_{A0}^{bv} - p_{AL}^{bv} = \frac{\lambda\theta}{6} + \frac{t\left[4\widehat{\beta}-\lambda\left(\widehat{\beta}-\beta^b\right)\right]}{3}$. □

The main point of this section is twofold. First, to show how the border coefficient is affected if there is a competition–variety–effect. A comparison between price differences in Lemmas 2 and 3 shows that border coefficients change due to local varieties within countries. In Lemma 2, the border coefficient is $\frac{4}{3}\beta$ while in Lemma 3 it is $\frac{\left[4\widehat{b}-\lambda\left(\widehat{b}+3\widetilde{b}\right)\right]}{3}$ in absolute terms. Second, there is a variety effect in Lemma 3 as part of the border coefficient. In addition to the border coefficient, the term $\frac{\lambda\theta}{6}$ in Lemma 3 will be added to the border if not accounted for in the estimation. These results are shown in the paper's main proposition.

Proposition 1. *Borders and local varieties interact for the price of traded products to diverge through two channels:*

1. *A variety effect* $\left(\frac{\lambda\theta}{6}\right)$
2. *An interaction variety-border effect* $\left(e.g.,.\ \frac{4}{3}t\beta\ vs.\ \frac{t\left[4\widehat{\beta}-\lambda\left(\widehat{\beta}-\beta^b\right)\right]}{3}\right)$

The variety effect measures how the price of the traded product is affected by considering different product varieties. This effect finds how consumers substitute varieties within countries. The interaction effect shows how the border is affected by the local product. It also helps to create, as more equal are $\widehat{\beta}$ and β^b less important are varieties in shifting consumer demand. Nevertheless, the variety effect is not directly affected by the border and is related to consumers' preferences (θ). This may explain why within countries borders are less critical than between countries (Beck, Kotz, and Zabelina, 2020).

4 Conclusions

This research highlights a crucial factor affecting the border effect estimations: variation in product variety across regions. In our model, borders and differences in varieties further increase price dispersion. Nevertheless, most papers in the literature disregard the information on local brands in their analysis. One potential correction could involve counting UPCs within a product category, as demonstrated by Borraz and Zipitría, 2022 and Cavallo, Feenstra, and Inklaar, 2023. Alternatively, in Borraz and Zipitría (2024), we propose using entropy indexes to measure differences in products in a given product category between markets and how it affects price dispersion.

References

Anderson, J., and E. van Wincoop (2001): "Borders, Trade, and Welfare," *Brookings Trade Forum*.

——— (2003): "Gravity with Gravitas: A Solution to the Border Puzzle," *American Economic Review*, 93(1), 170–192.

——— (2004): "Trade Costs," *Journal of Economic Literature*, XLII, 691–751.

Atkin, D., and D. Donaldson (2015): "Who's Getting Globalized? The Size and Implications of Intra-national Trade Costs," Working Paper 21439, National Bureau of Economic Research.

Beck, G. W., H.-H. Kotz, and N. Zabelina (2020): "Price gaps at the border: Evidence from multi-country household scanner data," *Journal of International Economics*, 127, 103368.

Borraz, F., and L. Zipitría (2022): "Varieties as a Source of Law of One Price Deviations," *International Economics*, 172, 1–14.

——— (2024): "Assessing Long-Run Price Convergence in Retailing," Discussion paper.

Broda, C., and D. E. Weinstein (2008): "Understanding International Price Differences Using Barcode Data," *NBER Working Paper 14017*.

Bronnenberg, B. J., J.-P. H. Dube, and M. Gentzkow (2012): "The Evolution of Brand Preferences: Evidence from Consumer Migration," *American Economic Review*, 102(6), 2472–2508.

Cavallo, A., R. C. Feenstra, and R. Inklaar (2023): "Product Variety, the Cost of Living, and Welfare across Countries," *American Economic Journal: Macroeconomics*, 15(4), 40–66.

Cavallo, A., B. Neiman, and R. Rigobon (2015): "The Price Impact of Joining a Currency Union: Evidence from Latvia," *IMF Economic Review*, 63(2), 281–297.

Coşar, A. K., P. L. Grieco, and F. Tintelnot (2015a): "Bias in estimating border- and distance-related trade costs: Insights from an oligopoly model," *Economics Letters*, 126, 147 – 149.

——— (2015b): "Borders, Geography, and Oligopoly: Evidence from the Wind Turbine Industry," *The Review of Economics and Statistics*, 97(3), 623–637.

CRUCINI, M. J., M. SHINTANI, AND T. TSURUGA (2010): “The Law of One Price without the Border: The Role of Distance versus Sticky Prices,” *The Economic Journal*, 120(544), 462–480.

DVIR, E., AND G. STRASSER (2018): “Does marketing widen borders? Cross-country price dispersion in the European car market,” *Journal of International Economics*, 112, 134 – 149.

ELBERG, A. (2016): “Sticky prices and deviations from the Law of One Price: Evidence from Mexican micro-price data,” *Journal of International Economics*, 98(C), 191–203.

ENGEL, C., AND J. H. ROGERS (1996): “How Wide is the Border?,” *American Economic Review*, 86(5), 1112–1125.

GOPINATH, G., P.-O. GOURINCHAS, C.-T. HSIEH, AND N. LI (2011): “International Prices, Costs, and Markup Differences,” *American Economic Review*, 101(6), 2450–86.

GORODNICHENKO, Y., AND L. TESAR (2009): “Border Effect or Country Effect? Seattle may not be so far from Vancouver after all,” *American Economic Journal – Macroeconomics*, 1(1), 219–241.

HANDBURY, J., AND D. WEINSTEIN (2015): “Good Prices and Availability in Cities,” *The Review of Economic Studies*, 82, 258–296.

HASKEL, J., AND H. WOLF (2001): “The Law of One Price - A Case Study,” *Scandinavian Journal of Economics*, 103(4), 545–558.

MCCALLUM, J. (1995): “National Borders Matter: Canada-U.S. Regional Trade Patterns,” *The American Economic Review*, 85(3), 615–623.

MESSNER, T., F. RUMLER, AND G. STRASSER (2023): “Cross-country price and inflation dispersion: retail network or national border?,” Working Paper Series 2776, European Central Bank.

PARSLEY, D. C., AND S.-J. WEI (2001): “Explaining The Border Effect: The Role of Exchange Rate Variability, Shipping Costs, and Geography,” *Journal of International Economics*, 55(1), 87–105.