Information Matters: Comparing Some Theoretical Determinants of Border Effects In Trade

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Abstract

There is widespread evidence that geographical borders reduce trade volumes. This paper presents a theoretical model capable of providing a succinct comparison of three broad explanations for this well-known ‘border effect’ or ‘home bias’, involving i) trade costs, ii) localized tastes, and iii) information frictions. Despite being traditionally under-researched as an explanation, it finds that information frictions often provide the relatively more powerful marginal effect in determining the border effect, and associated levels of welfare.

Keywords: Home Bias; Information Frictions; Search Costs; Localized Tastes; Trade Costs

JEL Codes: F10; L13; D83

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1 Introduction

A vast literature provides widespread evidence that geographical borders reduce trade volumes at both country- and state-level despite suitable controls for region size, distance and other relevant factors. Support for this well-known ‘border effect’ or ‘home bias’ holds across a broad range of markets and settings.

Further empirical findings suggest that traditional explanations for this phenomenon, such as the effects of tariffs and transportation costs, are unable to fully explain its prevalence. Instead, the findings point to a potential additional role for some less conventional explanations, including the existence of information frictions or localized tastes (see the surveys by Anderson and van Wincoop 2004 and Head and Mayer 2013). However, an explicit theoretical comparison of these rival explanations remains absent from the literature. Addressing this omission is important to help further understand the border effect and to guide policymakers towards the most appropriate tools for promoting trade and globalization.

As a first step towards such an aim, this paper presents a succinct model that can capture some theoretical mechanisms for three broad explanations, and compare their relative power in determining the border effect, and associated levels of welfare. In particular, it compares i) ‘trade costs’ including cross-border tariffs, transportation costs, transaction costs, and other trade barriers; ii) ‘localized tastes’ where buyers exhibit a (perceived) dis-utility of trading with sellers from outside their home region, and iii) ‘information frictions’ where buyers incur costs of gathering and interpreting information about sellers from regions other than their own. Despite being traditionally under-researched, our model provides the stark finding that information frictions often provide the relatively larger marginal effect on the border effect, and associated welfare.

Among other implications, this suggests that even small information frictions may be capable of offering a strong explanation of the border effect. Moreover, aside from traditional trade policies that aim to reduce tariffs or transportation costs, our results point to the potential merit of less-standard trade policies that aim to reduce information frictions. Such information based policies can improve the transparency and accessibility of price and product information, by for example, promoting online cross-border information sources or implementing common format/multi-lingual product labeling.

To provide a clean comparison between such broad explanations, we refrain from using
a full-scale trade model. Instead, we take an original step by ‘importing’ a simple version of a popular partial-equilibrium static information framework by Wolinsky (1986) that is being used increasingly to explain market phenomena (e.g. Bar-Isaac et al 2012, Haan and Moraga-González 2011, Armstrong et al 2009), and extending it into a trade context. In our model, each region has a single seller of a differentiated good and a set of domestic buyers. Buyers can trade freely with their ‘home’ seller. Alternatively, to trade with a ‘foreign’ seller from a region other than their own, buyer must first incur a cross-border information cost to identify and/or interpret the seller’s product and price. This captures the possibility that information about foreign products and prices is harder to obtain, and/or harder to interpret as it may be presented in a different format or language. Buyers can gather information about any number of foreign sellers under a standard sequential search process, incurring the cross-border information cost each time. After having decided to stop searching, a buyer can then exit, trade with its home seller, or trade with a searched foreign seller. However, buying from a foreign seller may i) be less attractive for the buyer due to a relative preference for home produce through localized tastes, and ii) require the buyer and/or the foreign seller to further incur a trade cost, as consistent with various cross-border tariffs, transportation costs, transaction costs, or other trade barriers.

The paper then derives the equilibrium prices and trade patterns. We demonstrate the different mechanisms by which changes in the level of trade costs, information frictions, and localized tastes influence the border effect and welfare, through their effects on buyer behavior and market prices. However, we show that information frictions often generate the largest marginal effects. This arises because buyers’ optimal search behavior is relatively more sensitive to the level of information frictions, which then makes them especially potent in deterring buyers from considering offers from foreign sellers.

Finally, the paper examines two extensions to demonstrate the robustness of our results. First, in contrast to the main model where each seller is able to set different prices to buyers from different regions, we re-examine our results when sellers are constrained to set only a single ‘world’ price. Second, and more substantially, we consider an alternative form of trade costs. In a recent paper, Sørensen (2014) stresses the relative theoretical and empirical importance of additive ‘per-unit’ trade costs that do not vary in the level of a product’s price, as consistent with some common forms of transportation costs, transaction costs and tariffs. While our main model focuses on this form of trade cost, we also re-examine our results
under the more complex case of multiplicative ‘iceberg’ trade costs that vary in a product’s price.

Our paper builds most closely on Wilson (2012) who uses a version of Wolinsky (1986) to examine the relative impact of search costs and switching costs on market power and welfare. Here, we i) adapt and extend his analysis to a qualitatively different multi-region trade context, ii) provide a general re-interpretation of his switching cost variable to capture both buyer trade costs and localized tastes, iii) add a new and qualitatively different explanatory variable to capture the effects of seller trade costs, and iv) develop a theoretical measure of the border effect for this setting and show how this measure, together with measures of welfare, vary under all the listed explanations.

Our paper adds to the emerging theoretical literature on information and trade (e.g. Allen 2014, Dasgupta and Mondria 2014, Eaton et al 2014 and Alboronoz et al 2012). Closest are the papers by i) Allen (2014) who provides a detailed analysis of trade when sellers undergo an optimal search process to find the best regional price, and ii) Dasgupta and Mondria (2014) who consider information frictions in the form of rational buyer inattention in order to provide a full foundation for the gravity equation of trade. In contrast, we consider buyer information frictions in the form of optimal buyer search, and concentrate on providing a simple model to explicitly demonstrate the relative power of information frictions in determining the border effect and associated welfare when compared to a range of other competing explanations.

Our results also complement a number of recent empirical papers that document the role of information in determining border effects and trade. For instance, Frink et al (2005) and Portes and Rey (2005) show how communication costs and communication traffic help explain trade patterns, while Allen (2014) finds evidence of substantial information frictions in regional agriculture. Other empirical work demonstrates how border effects still prevail in online markets, while detailing the role of information barriers in the form of language differences (Gomez-Herrara et al 2014) and variations in the level of trust (Hortaçsu et al 2009 and Lendle et al 2012). Our paper helps underpin this research by demonstrating the relative theoretical significance of information frictions, and by further understanding the channels by which information affects trade.
2 Model

Consider a market with \( n \) regions. Within each region there is a single seller of a differentiated good. Without loss, production costs are normalized to zero. Buyers are symmetrically distributed across regions and the number of buyers per region is normalized to one. Buyers have quasi-linear preferences and a unit demand. In particular, excluding other potential trading costs, let buyer \( m \) gain an indirect utility, \( u_{mi} = \varepsilon_{mi} - p_i \), if it buys from seller \( i \) at price \( p_i \), where \( \varepsilon_{mi} \) is an idiosyncratic, privately-observed match value that reflects how buyer \( m \) values seller \( i \)'s differentiated product. Each match \( \varepsilon_{mi} \) is drawn independently from a distribution \( G(\varepsilon) \) on \( [\varepsilon, \bar{\varepsilon}] \) where \( 0 \leq \varepsilon < \bar{\varepsilon} \). Any buyer who chooses not to buy within the market, receives a zero outside option utility.

Our main model allows each seller to set different prices to buyers from different regions. Under our later assumptions, this implies that each seller \( i \) will find it optimal to set a ‘home’ price, \( p_{ih} \), to buyers from its own region, and a ‘foreign’ price, \( p_{if} \), to buyers from all other regions. However, in Section 6.1, we relax this assumption by allowing each seller to only set a single ‘world’ price.

Let any trade between a buyer and its home seller be unrestricted. Specifically, any buyer \( m \) with home seller \( i \) can freely learn \( i \)'s home price, \( p_{ih} \), and its match at \( i \), \( \varepsilon_{mi} \), and then choose to trade with \( i \) at zero cost. In contrast, any trade between buyer \( m \) and a ‘foreign’ seller from a region other than its home region, \( j \neq i \), is open to a number of frictions and barriers. In particular, to trade with a foreign seller \( j \), buyer \( m \) must first incur a cross-border information friction or ‘search cost’, \( c > 0 \), in order to identify and interpret seller \( j \)'s foreign price, \( p_{jf} \), and its product match at \( j \), \( \varepsilon_{mj} \). In line with a standard sequential search procedure, buyers can search any number of foreign sellers sequentially, incurring a fixed cost of \( c \) each time, with the free ability to return to previously searched sellers. Hence, after each search, a buyer can keep searching further foreign sellers, trade with its home seller, or trade with any searched foreign seller.

However, additional trade costs must be incurred to trade with any searched foreign seller, as consistent with various forms of cross-border tariffs, transportation costs, transaction costs, or other trade barriers. In our main model, we focus on additive ‘per-unit’ trade costs. However, Section 6.2, later extends our results to the alternative multiplicative ‘iceberg’ form of trade costs. Given our framework, it is useful to break down these trade costs into those
borne by the buyer and those borne by the seller. Thus, in any foreign transaction, the buyer must incur a ‘buyer trade cost’ $\gamma_b > 0$ and the seller must incur a ‘seller trade cost’ $\gamma_s > 0$. Under this structure, note that the buyer trade cost, $\gamma_b$, can also be interpreted as a buyer’s (perceived) dis-utility for foreign trade, as consistent with localized tastes. However, for brevity, in what follows, this is just denoted as a form of buyer trade cost, $\gamma_b$.

We consider a one-shot game where the players select their strategies simultaneously. Sellers each choose their prices, while buyers form conjectures about the sellers’ prices and select their own strategies. For any given match and price from buyer $m$’s home seller, $\{\varepsilon_{mi}, p_{ih}\}$, the buyer strategy for buyer $m$ must prescribe how many and which foreign sellers to search, and which seller, if any, to trade with. We focus on the symmetric equilibrium with home price, $p_h^*$, and foreign price, $p_f^*$. Therefore, all foreign sellers are identical ex ante and so buyers are indifferent over which foreign sellers to search. Hence, after observing their home seller’s offer, $\{\varepsilon_i, p_{ih}\}$ (dropping subscript $m$), any buyer strategy must only prescribe whether to start searching, when to stop searching, and which seller to then trade with, if any.

Finally, given the breadth of our model, we simplify our analysis with two assumptions. Without these assumptions, it quickly becomes difficult to derive the equilibrium and/or provide tractable comparative statics. First, we assume that the number of regions is large, with $n \to \infty$. This is consistent with a global trading environment with many nations or a national market with many geographic regions. The difficulties of working with a smaller number of sellers are well known in the Wolinsky framework due to the awkward existence of ‘return’ buyers who begin searching but then later decide to return to buy from their original home supplier. In our broader trade context, these complexities are particularly acute. Hence, like other papers that seek tractability, such as Bar Isaac et (2012), we assume $n \to \infty$ to ensure that all searching buyers never return to their original seller. Second, like Wilson (2012) and Armstrong et al (2009), we focus on a uniform match distribution; $G(\varepsilon) = \frac{(\varepsilon - \xi)}{(\bar{\varepsilon} - \xi)}$ on $[\xi, \bar{\varepsilon}]$, with density $g(\varepsilon) = \frac{1}{(\bar{\varepsilon} - \xi)}$, where $0 \leq \xi < \bar{\varepsilon}$ and $\bar{\varepsilon} - \xi \geq 1$.

3 Equilibrium

Consider the optimal strategy for a buyer with home seller $i$, given home price, $p_{ih}$, home match, $\varepsilon_i$, and the expectation that all other sellers set a foreign price, $p_f^*$. 
Lemma 1. Define the standard reservation utility, \( \hat{x} \), as the unique value of \( x \) that solves
\[
c = \int_{\hat{x}}^{\infty} (\varepsilon - x) g(\varepsilon) d\varepsilon,
\]
such that \( \hat{x} = \varepsilon - \sqrt{2c(\varepsilon - \bar{\varepsilon})} < \bar{\varepsilon} \). Then, the optimal buyer strategy involves:

Step 1: Search any foreign seller and move to Step 2 if \( \max\{0, \varepsilon_i - p_{ih}\} < \hat{x} - \gamma_b - p_j^* \). Otherwise, buy from home seller \( i \) if \( \varepsilon_i - p_{ih} > 0 \), and exit if not.

Step 2: After finding a foreign seller \( j \) with foreign price, \( p_{jf} \), and match, \( \varepsilon_j \), stop searching further foreign sellers only if \( \varepsilon_j \geq \hat{x} + p_{jf}^* - p_j^* \), and then buy from \( j \).

As seller trade costs, \( \gamma_s \), do not influence optimal buyer behavior for a given set of prices, this result follows as a simple modification and re-interpretation of Lemma 1 in Wilson (2012) and so we omit its proof. However, because the result forms the platform for our remaining analysis, we now provide a detailed account of its intuition.

The full optimal search problem can be condensed to two steps. In Step 1, a buyer decides whether to start searching beyond its home seller. Using standard induction arguments, this optimally reduces to a seemingly myopic comparison between the buyer’s effective home offer, \( \max\{0, \varepsilon_i - p_{ih}\} \), and the expected gains from searching one foreign seller. To calculate these latter expected gains, note that the buyer would only prefer the searched foreign offer (net of buyer trade costs), \( \varepsilon_j - p_j^* - \gamma_b \), to its effective home offer if \( \varepsilon_j > \max\{0, \varepsilon_i - p_{ih}\} + p_j^* + \gamma_b \equiv x \). Thus, given a cost of search, \( c \), the expected net gains are

\[
-c + \int_{\hat{x}}^{\infty} \max\{0, \varepsilon_i - p_{ih}\} g(\varepsilon) d\varepsilon_j + \int_{\hat{x}}^{\varepsilon} (\varepsilon_j - p_j^* - \gamma_b) g(\varepsilon_j) d\varepsilon_j
\]

Equating this to the effective home offer then implies that the buyer is indifferent over whether to start searching when \( c = \int_{\hat{x}}^{\infty} (\varepsilon - x) g(\varepsilon) d\varepsilon \) which gives the expression for \( \hat{x} \) in Lemma 1. As consistent with Step 1, the buyer will then only start searching when \( x < \hat{x} \) or equivalently, when \( \max\{0, \varepsilon_i - p_{ih}\} < \hat{x} - \gamma_b - p_j^* \). If the buyer decides not to search, then it buys from its home seller if \( \varepsilon_i - p_{ih} > 0 \) and otherwise exits. If the buyer does decide to start searching the foreign sellers, then it moves to Step 2.

In Step 2, after searching, if the buyer finds a foreign offer that is inferior to that provided by the home seller then clearly it should continue searching. However, on finding a foreign offer from some seller \( j \) that exceeds the buyer’s home offer, \( \varepsilon_j - p_{jf} - \gamma_b > \max\{0, \varepsilon_i - p_{ih}\} \), the buyer then faces a more substantial decision of whether or not to keep searching further foreign sellers. Using similar logic to above, this optimally reduces to a myopic comparison.
between the current foreign offer $\varepsilon_j - p_{jf} - \gamma_b$ and the expected net benefits of making one further search to discover an additional offer from some foreign seller $l$, $\varepsilon_l - p_{lf}^* - \gamma_b$. To calculate these expected gains, note that the buyer would only prefer the new foreign offer, $\varepsilon_l - p_{lf}^* - \gamma_b$, to its current foreign offer if $\varepsilon_l > \varepsilon_j - (p_{jf} - p_{lf}^*) \equiv x'$. Thus, given a cost of search, $c$, the expected net gains are

$$-c + \int_{\xi}^{x'} (\varepsilon_j - p_{jf} - \gamma_b)g(\varepsilon_l)d\varepsilon_l + \int_{x'}^{\xi} (\varepsilon_l - p_{lf}^* - \gamma_b)g(\varepsilon_l)d\varepsilon_l$$  \hspace{1cm} (2)

Equating this to the current foreign home offer then implies that the buyer is indifferent over whether to start searching when $c = \int_{\xi}^{x'} (\varepsilon - x')g(\varepsilon)d\varepsilon$ which is also consistent with the expression for $\hat{x}$ in Lemma 1. In line with Step 2, the buyer will then only stop searching and buy when $x' \geq \hat{x}$ or equivalently, when $\varepsilon_j \geq \hat{x} + p_{jf} - p_{lf}^*$. Note, this decision is independent of buyer trade costs, $\gamma_b$, because the buyer will always buy from either the current foreign seller or another foreign seller and therefore incur $\gamma_b$ regardless.

Finally, note that if the buyer chooses to start searching in Step 1, then it will always eventually find a better foreign deal and so never return to buy from its home seller because $n \to \infty$.

We now move on to establishing equilibrium prices. First, from Step 1, no buyer will ever search in equilibrium if $\max\{0, \varepsilon - p_h^*\} \geq \hat{x} - \gamma_b - p_{lf}^*$. This creates a state of autarky with zero foreign trade and a maximal border effect. Therefore, from this point forward, we focus on the more interesting case with:

$$\max\{0, \varepsilon - p_h^*\} < \hat{x} - \gamma_b - p_{lf}^*$$ \hspace{1cm} (Condition 1)

Now consider seller $i$’s residual home demand when all other sellers set a foreign price, $p_{lf}^*$:

$$D_{ih}(p_{ih}; p_{lf}^*) = 1 - G(\hat{x} - \gamma_b + p_{ih} - p_{lf}^*)$$  \hspace{1cm} (3)

This derives from $i$’s home buyers who do not search. To not search, such buyers must have $\varepsilon_i$ such that $\max\{0, \varepsilon_i - p_{ih}\} \geq \hat{x} - \gamma_b - p_{lf}^*$. They will then always buy from $i$ rather than exiting because it follows that $\varepsilon_i - p_{ih} > 0$ via Condition 1. Therefore, the probability that a buyer purchases at home is $1 - G(\hat{x} - \gamma_b + p_{ih} - p_{lf}^*)$. 

8
Next, consider $i$’s residual foreign demand when all other sellers set home and foreign prices, $p_h^*$ and $p_f^*$:

$$D_{if}(p_{if}; p_h^*, p_f^*) = G(\hat{x} - \gamma_b + p_h^* - p_f^*) \cdot \frac{1}{1 - G(\hat{x})} \cdot (1 - G(\hat{x} + p_{if} - p_f^*)) \quad (4)$$

To derive this equation, note that any given buyer that is foreign to region $i$ starts searching from their home seller with probability $G(\hat{x} - \gamma_b + p_h^* - p_f^*)$. Hence, when aggregated across all foreign regions, we know that $(n-1)G(\hat{x} - \gamma_b + p_h^* - p_f^*)$ foreign buyers start searching. The probability that any such foreign buyer then searches $i$ at any point during their search process equals

$$\frac{1}{(n-1)}[1 + G(\hat{x}) + G(\hat{x})^2 + ... + G(\hat{x})^{n-2}] = \frac{1}{(n-1)} \sum_{k=0}^{n-2} G(\hat{x})^k = \frac{1}{(n-1)(1-G(\hat{x}))}$$

because buyers i) select which sellers to search randomly, and ii) then keep searching beyond any searched seller $k \neq i$ with the probability that $\varepsilon_k < \hat{x}, G(\hat{x})$. Then, conditional on searching $i$, we know a foreign buyer buys at $i$ with the probability that $\varepsilon_i \geq \hat{x} + p_{if} - p_f^*$, which equals $1 - G(\hat{x} + p_{if} - p_f^*)$.

Given these demand functions, each seller then maximizes its total profits, where the revenue from any foreign buyer is also subject to the seller trade cost, $\gamma_s$:

$$\text{Max}_{p_{ih}, p_{if}} \pi_i(.) = p_{ih}D_{ih}(p_{ih}^*, p_{if}^*) + (p_{if} - \gamma_s)D_{if}(p_{if}^*; p_h^*, p_f^*) \quad (5)$$

Proposition 1 then follows, where each price reflects the relevant information frictions and trade costs as explained further within the next section. (All proofs are listed in the appendix unless otherwise stated).

**Proposition 1.** The unique symmetric equilibrium prices are:

$$p_h^* = \bar{\varepsilon} - \hat{x} + \frac{\gamma_s + \gamma_b}{2} \quad (6)$$

$$p_f^* = \bar{\varepsilon} - \hat{x} + \gamma_s \quad (7)$$

### 4 The Border Effect

From (3), we know that the equilibrium proportion of buyers that buy from their home region can be expressed as the proportion of buyers that optimally decide not to start searching.
This is re-defined as $B$ in (8) below. We then propose that $B$ forms a natural measure of the border effect in our context; when the explanatory variables, $c$, $\gamma_b$, and $\gamma_s$, tend to zero, then (almost) all buyers buy from foreign regions and there is no border effect, such that $B$ converges to zero, but when the explanatory variables become large (such that Condition 1 just fails), then (almost) all buyers buy from their home region and there is a strong border effect, such that $B$ converges to one.

$$B = D_{ih}(p_h^*; p_f^*) = 1 - G(\hat{x} + p_h^* - p_f^* - \gamma_b)$$

Conversely, the complement of our border effect measure, $T = 1 - B = D_{if}(p_h^*; p_f^*)$, forms a measure of cross-border trade by expressing the equilibrium proportion of buyers that buy from a foreign seller.

We now consider how marginal changes in the explanatory variables affect the border effect, $B$, (and therefore also the cross-border trade measure, $T$). Such changes affect $B$ either directly, and/or indirectly through their effects on prices.

First, consider the effects on $B$ from an increase in buyers’ trade costs or their (perceived) dis-utility of foreign trade, $\gamma_b$, with reference to (9). There is no effect on $p_f^*$ because additional foreign search decisions are independent of $\gamma_b$, $\partial p_f^*/\partial \gamma_b = 0$. However, an increase in $\gamma_b$ i) allows sellers to raise $p_h^*$ because trading with a foreign seller is now more costly, $\partial p_h^*/\partial \gamma_b = 0.5$, and ii) produces a larger off-setting direct effect in deterring buyers from starting to search any foreign sellers, such that $B$ increases.

$$\frac{\partial B}{\partial \gamma_b} = -\frac{1}{(\bar{\varepsilon} - \bar{\varepsilon})} \left[ \frac{\partial p_h^*}{\partial \gamma_b} - \frac{\partial p_f^*}{\partial \gamma_b} - 1 \right] = \frac{1}{2(\bar{\varepsilon} - \bar{\varepsilon})} > 0$$

Second, consider an increase in sellers’ trade costs, $\gamma_s$, (10). This produces no direct effect. However, it prompts sellers to raise $p_f^*$ by increasing their costs of foreign transactions, $\partial p_f^*/\partial \gamma_s = 1$. In turn, this softens competition and so also induces a smaller rise in $p_h^*$, $\partial p_h^*/\partial \gamma_s = 0.5$. This net price change deters buyers from searching and so increases $B$.

$$\frac{\partial B}{\partial \gamma_s} = -\frac{1}{(\bar{\varepsilon} - \bar{\varepsilon})} \left[ \frac{\partial p_h^*}{\partial \gamma_s} - \frac{\partial p_f^*}{\partial \gamma_s} \right] = \frac{1}{2(\bar{\varepsilon} - \bar{\varepsilon})} > 0$$
While their mechanisms differ, (9) and (10) show that the marginal effects from $\gamma_b$ and $\gamma_s$ are equal - our measures of the border effect and cross-border trade are independent of whether trade costs are borne by sellers or buyers.

Now consider an increase in information frictions, $c$, (11). An increase in $c$ deters search in Step 1 and Step 2 in the same way via $\hat{x}$. This prompts sellers to raise $p_h^*$ and $p_f^*$ by an equal amount such that the price effects on $B$ cancel. This leaves only a direct effect in deterring buyers from starting to search, $-\frac{\partial \hat{x}}{\partial c} = \frac{(\varepsilon - \bar{\varepsilon})}{(\varepsilon - \bar{\varepsilon})} > 0$, which raises $B$.

$$\frac{\partial B}{\partial c} = -\frac{1}{(\varepsilon - \bar{\varepsilon})} \left[ \frac{\partial \hat{x}}{\partial c} + \frac{\partial p_h^*}{\partial c} - \frac{\partial p_f^*}{\partial c} \right] = -\frac{1}{(\varepsilon - \bar{\varepsilon})} \cdot \frac{\partial \hat{x}}{\partial c} > 0 \quad (11)$$

We can then state:

**Proposition 2.** The marginal effects from an increase in information frictions, $c$, on the border effect, $B$, and cross-border trade, $T$, are always larger than the marginal effects from an increase in seller trade costs, $\gamma_s$, or buyer trade costs, $\gamma_b$.

The intuition for this result is rather subtle, and one must take care to avoid some misleading explanations. For instance, the result does not derive from the fact that trade costs can only be incurred once and yet information frictions can be incurred multiple times by searching different sellers. Instead, as shown in (11), information frictions provide a more powerful determinant of the border effect because of their specific effects in discouraging buyers to search foreign sellers via the reservation utility, $\hat{x}$. From Step 1 of Lemma 1, this reservation utility derives from the optimal, yet seemingly-myopic, comparison between a buyer’s effective home offer and their expected net gains from searching one foreign seller. In particular, when assessing the expected net gains, (1), a buyer views information frictions as a particularly powerful deterrent as they know that $c$ will be incurred with certainty, but that trade costs, $\gamma_b$ and $\gamma_s$ (via $p_f^*$), will only be incurred with the lesser probability that the next search leads to the discovery of foreign offer that is attractive enough to induce a cross-border transaction.

Proposition 2 makes some clear empirical predictions for home and foreign trade. However, explicit empirical comparisons of the effects of the different explanatory variables are rare because of the difficulties of measuring information frictions. Nevertheless, some tentative evidence can be offered if one considers proxies for information costs. In particular, while no formal tests are provided to compare our variables of interest, a few papers report...
that information cost proxies, such as telecommunication costs or the existence of a common language, are statistically more significant in determining cross-border trade volumes than some more traditional trade costs, such as shipping costs or tariff levels (e.g. Gomez-Herrera 2014, Lendle et al 2012, Frink et al 2005). Future work in this direction would be useful to further test our model and explicitly compare competing explanations.

5 Welfare

Using the logic of the previous section, we now extend the spirit of our results to welfare. However, to avoid any awkward conceptual comparisons, we drop the (perceived) dis-utility interpretation of $\gamma_b$.

**Proposition 3.** Relative to a marginal increase in seller trade costs, $\gamma_s$, or buyer trade costs, $\gamma_b$, a marginal increase in information frictions, $c$, always leads to a greater increase in seller profits, and a larger reduction in buyer surplus and total welfare.

First, consider seller profits. Using (5) and (8), a seller’s equilibrium profits can be expressed as 
$$
\pi_i^* = p_h^*B + (p_f^* - \gamma_s)(1 - B),
$$
where it can also be shown that $p_h^* > p_f^* - \gamma_s$. Then, relative to the trade costs, $\gamma_s$ and $\gamma_b$, information frictions always increase profits by a larger amount because they produce a bigger marginal effect in raising $p_h^*$, $p_f^*$, and $B$.

Now consider the effects of a marginal increase in any of the explanatory variables on buyer surplus. These effects are more complex. However, by adapting standard envelope-arguments from Wilson (2012), we know that any indirect effects on buyer surplus that result from a change in buyer behavior are only second-order in magnitude. This follows because such buyers must have previously been indifferent between the relevant actions in order for the marginal change to have had any qualitative effect on their behavior. Hence, the only possible first-order direct effects on buyer surplus stem from i) any increase in prices, for given levels of existing home and foreign demand, and ii) any increase in the resource costs of existing search activity or existing cross-border transactions. Due to their relative potency in influencing buyers’ search decisions, the proof then verifies that information frictions provide the relatively larger marginal effect because they generate larger marginal price effects on $p_h^*$ and $p_f^*$, and larger marginal resource costs.

Finally, consider total welfare. As all buyers buy in equilibrium, we know that the effects of any increased prices only result in a welfare transfer from buyers to sellers. Therefore,
using our previous arguments, the only first-order effects concern the increase in resource costs of existing search activity or existing cross-border transactions. From above, it then follows that information frictions provide the relatively larger marginal effect.

6 Robustness

In this final section, we consider two extensions to examine the robustness of our results.

6.1 Single Prices

The main model assumed that each seller \( i \) could set different prices to buyers from different regions. Here, we now consider an alternative case where each seller \( i \) can only set a single ‘world’ price to all buyers, \( p_i \):

**Proposition 4.** When each seller can only set a single price to all buyers, information frictions still exert the relatively larger marginal effect on the border effect, cross-border trade, and total welfare.

In the resulting symmetric equilibrium, the sellers set a single price \( p^* \), such that the border effect measure in (8) now equals \( B = D_{bh}(p^*) = 1 - G(\hat{x} - \gamma_b) \). This is now independent of prices, and so the associated price effects in (9)-(11) become neutralized. This leaves only the direct effects, which we know favor information frictions due to their relative power in deterring foreign trade. In terms of welfare, the existence of a single price makes it difficult to explicitly rank the relative comparative statics for seller profits and buyer surplus. However, by applying our previous logic, one can still show that information frictions exert the largest effect on total welfare.

6.2 Alternative Trade Costs

The main model focused on additive ‘per-unit’ trade costs. As argued by Sørensen (2014) and the references therein, such trade costs are common, and important both theoretically and empirically. However, we now consider an alternative case with multiplicative ‘iceberg’ trade costs that are proportional to a product’s price. Here, a buyer’s trade cost for trading with foreign seller \( j \) under \( j \)’s foreign price \( p_{jf} \) can be redefined as \( \gamma_{bj} = \phi_b p_{jf} \), where \( \phi_b > 0 \)
reflects the strength of buyer trade barriers. Similarly, seller’s $j$’s trade cost for trading with any foreign buyer can be denoted as $\gamma_{sj} = \phi_sp_{jf}$, where $\phi_s > 0$ reflects the strength of seller trade barriers.

Information frictions do not follow this multiplicative structure because the costs of identifying a seller’s offer are not dependent upon the actual price charged. Hence, it now becomes conceptually harder to make a like-for-like comparison between a marginal change in information frictions (in monetary units) and trade costs (as a proportion of product prices). Nevertheless, if one is willing to make such a comparison, we can state the following where we now denote each seller’s marginal production costs as $k \geq 0$:

**Proposition 5.** Under iceberg trade costs, information frictions still exert the relatively larger marginal effect on the border effect, cross-border trade, buyer surplus, seller profits and total welfare, when marginal production costs, $k$, are sufficiently small.

Intuitively, in equilibrium, buyer and seller trade costs, $\gamma_{bj} = \phi_bp_f^*$, and $\gamma_{sj} = \phi_sp_f^*$, are proportional to equilibrium prices, which, in turn, are dependent upon the level of marginal production costs, $k$. When production costs are small enough, equilibrium prices are relatively low, and so the effects of a marginal change in the strength of buyer trade costs, $\phi_b$, or seller trade costs, $\phi_s$, remain smaller than the effects from a marginal change in information frictions. However, when production costs and the resultant equilibrium prices are sufficiently large, it is not surprising that the effects of a marginal change in the strength of buyer or seller trade costs can dominate the effects of a marginal change in information frictions.

7 Conclusion

This paper has extended a simple version of the popular information framework by Wolinsky (1986) into a trade context, in order to provide a succinct comparison of some theoretical mechanisms for three explanations of the border effect. The traditionally under-researched explanation of information frictions was found to often generate the relatively larger marginal effect on the border effect, and associated welfare.

We hope that future research can build on our work in at least three ways. First, further work should generalize, expand and test our findings to develop the implication that policymakers may wish to focus more on information-based policy remedies in order to better
promote trade and globalization. Second, future work would be useful to widen our comparison to include additional explanations for the home bias, such as an explicit analysis of the information-related ‘trust’ mechanism recently highlighted empirically by Hortaçsu et al (2009) and Lendle et al (2012). However, the addition of this mechanism is only likely to strengthen our findings about the relative importance of information in determining trade. Finally, and more generally, we hope that future research can build on our framework to analyze further information-related trade questions.

Appendix:

**Proof of Proposition 1:** \( \pi_i \) in (5) is continuous and quasi-concave in both \( p_{ih} \) and \( p_{if} \) over the relevant range. Hence, when evaluated at equilibrium, i) the FOC with respect to \( p_{if} \) gives the unique price; (7), and ii) the FOC with respect to \( p_{ih} \) gives \( p_{ih}^* = \frac{1}{2}[\xi - \hat{x} + p_f^* + \gamma_b] \), which after substituting for \( p_f^* \) gives the unique price; (6).

**Proof of Proposition 2:** From (9)-(11), the result for the border effect, \( B \), requires \( -\frac{\partial \hat{x}}{\partial c} > \frac{1}{2} \). This follows as \( \frac{\xi - \hat{x}}{\xi - \hat{x}} > 1 \) because i) \( \hat{x} < \xi \) from Lemma 1, and ii) \( \hat{x} > \xi + \frac{\gamma_s + \gamma_b}{2} > \xi \) from Condition 1 when evaluated with equilibrium prices. The result for cross-border trade then follows immediately as \( T = 1 - B \).

**Proof of Proposition 3:** First, consider a seller’s profits, \( \pi_i^* = p_{ih}^* B + (p_{if}^* - \gamma_s)(1 - B) \). Using (6)-(11), we can then state that \( \frac{\partial \pi_i^*}{\partial c} = -\frac{\partial \hat{x}}{\partial c}[1 + \frac{\gamma_s + \gamma_b}{2(\xi - \hat{x})}] \) is strictly larger than \( \frac{\partial \pi_i^*}{\partial \gamma_s} = \frac{\partial \pi_i^*}{\partial \gamma_b} = \frac{1}{2}[B + \frac{\gamma_s + \gamma_b}{2(\xi - \hat{x})}] > 0 \) by using \( B \in (0,1) \) and \( -\frac{\partial \hat{x}}{\partial c} > 1 \) from past results. Second, consider buyer surplus and denote \( C \) as the equilibrium number of searches, and \( F \) as the equilibrium number of cross-border transactions. From the text, the only possible first-order effects from a marginal change in an explanatory variable, \( z \), involve the effects on i) increased prices for given levels of demand, \( n[\frac{\partial \pi_i^*}{\partial z} B + \frac{\partial \pi_i^*}{\partial z} (1 - B)] \), ii) increased total resource costs for existing search activity, \( C \frac{\partial c}{\partial z} \), and iii) increased total resource costs for existing cross-border transactions, \( F \frac{\partial (\gamma_s + \gamma_b)}{\partial z} \). Information frictions, \( c \), then produce the larger total marginal effect. This follows because i) they produce larger marginal effects on both \( p_{ih}^* \) in (6) and \( p_{if}^* \) in (7) as \( -\frac{\partial \hat{x}}{\partial c} > 1 \), and ii) because they produce larger resource effects as the equilibrium number
of searches, $C$, is strictly larger than the equilibrium number of cross-border transactions, $F$, with $C_F = \frac{G(\hat{x} - \gamma_b + p_i - p_f^*)}{G(\hat{x} - \gamma_b + p_h - p_f^*)} > 1$. Finally, using the text, the proof for total welfare follows immediately as we need only consider the resource effects in ii) above.

$\square$

**Proof of Proposition 4:** Lemma 1 remains with $p_i = p_{ih} = p_{ij}$ and $p^* = p_h^* = p_f^*$. Then, with the assumption that $\gamma_s$ is not so high that it prevents profitable trade to foreign regions, and under a revised Condition 1: $\max\{0, \xi - p^*\} < \hat{x} - \gamma_b - p^*$, each seller $i$ must now maximize $\pi_i(.) = p_i D_{ih}(p_i; p^*) + (p_i - \gamma_s) D_{if}(p_i; p^*)$ where $D_{ih}(p_i; p^*) = 1 - G(\hat{x} - \gamma_b + p_i - p^*)$ and $D_{if}(p_i; p^*) = G(\hat{x} - \gamma_b) \cdot \frac{1}{(1-G(\hat{x}))} \cdot (1 - G(\hat{x} + p_i - p^*))$. The resulting equilibrium price is $p^* = \frac{(\gamma_s - (1-G(\hat{x})) + \gamma_s G(\hat{x} - \gamma_b))}{1-G(\hat{x}) + G(\hat{x} - \gamma_b)}$. The measures for the border effect and cross-border trade are now independent of prices as $B = D_{ih}(p^*) = 1 - G(\hat{x} - \gamma_b)$. Therefore, by modifying the arguments of Proposition 2, we know that $\frac{\partial B}{\partial c} = -\frac{1}{(\tau - 2)} \cdot \frac{\partial \hat{x}}{\partial c}$ is strictly larger than $\frac{\partial B}{\partial \gamma} = \frac{1}{(\tau - 2)}$ and $\frac{\partial B}{\partial \gamma_s} = 0$. Finally, for total welfare, using past arguments, we only require the equilibrium ratio of total searches to total cross-border transactions to exceed one. This still follows as $\frac{G(\hat{x} - \gamma_b) \cdot \frac{1}{(1-G(\hat{x}))}}{G(\hat{x} - \gamma_b)} > 1$.

$\square$

**Proof of Proposition 5:** The proof proceeds with a number of claims that mirror the structure and derivation of the main results. First, consider the optimal strategy for a buyer with home seller $i$, given home price, $p_{ih}$, home match, $\varepsilon_i$, and the expectation that all other sellers set a foreign price, $p_{fj}^*$.

**Claim 1.** Under iceberg buyer trade costs, $\gamma_{bij} = \phi_b p_{fj}$, the optimal buyer strategy involves:

*Step 1:* Search any foreign seller and move to Step 2 if $\max\{0, \varepsilon_i - p_{ih}\} < \hat{x} - p_f^*(1 + \phi_b)$. Otherwise, buy from home seller $i$ if $\varepsilon_i - p_{ih} > 0$, and exit if not.

*Step 2:* After finding a foreign seller $j$ with foreign price, $p_{fj}$, and match, $\varepsilon_j$, stop searching further foreign sellers only if $\varepsilon_j \geq \hat{x} + (p_{fj} - p_f^*)(1 + \phi_b)$, and then buy from $j$.

Claim 1 follows a simple adaptation of Lemma 1. In brief, it can be derived as follows. For Step 1, a buyer now expects to discover a first foreign offer of $\varepsilon_j - p_f^* - \phi_b p_{fj}^*$. By following the steps in the main model, it can be verified that the buyer will start search only if $\max\{0, \varepsilon_i - p_{ih}\} < \hat{x} - p_f^*(1 + \phi_b)$. For Step 2, a buyer now compares a current foreign offer $\varepsilon_j - p_{fj} - \phi_b p_{fj}$ with an expected new offer of $\varepsilon_i - p_f^* - \phi_b p_f^*$. By following the steps in the main model, it can be verified that the buyer will stop and buy if $\varepsilon_j \geq \hat{x} + (p_{fj} - p_f^*)(1 + \phi_b)$.
Note in contrast to the main model, buyer trade costs matter in Step 2 if \( p_{jf} \neq p^*_f \) because they are now price dependent.

**Claim 2.** Under iceberg trade costs with marginal production costs, \( k \geq 0 \), the unique symmetric equilibrium prices are:

\[
\begin{align*}
    p^*_h &= (\bar{x} - \hat{x}) + \frac{k}{2} \left( 1 + \frac{1 + \phi_b}{1 - \phi_s} \right) \\
    p^*_f &= \left( \frac{\bar{x} - \hat{x}}{1 + \phi_b} \right) + \left( \frac{k}{1 - \phi_s} \right)
\end{align*}
\]

(12)

(13)

Using Claim 1, one can ensure that some buyers search by stating a new version of Condition 1, \( \max\{0, \xi - p^*_h\} < \hat{x} - p^*_f(1 + \phi_b) \). Seller \( i \)'s residual home demand when all other sellers set a foreign price, \( p^*_f \), now equals \( D_{ih}(p_{ih}; p^*_f) = 1 - G(\hat{x} + p_{ih} - p^*_f(1 + \phi_b)) \), and seller \( i \)'s residual foreign demand when all other sellers set home and foreign prices, \( p^*_h \) and \( p^*_f \) is now \( D_{if}(p_{if}; p^*_h, p^*_f) = G(\hat{x} + p^*_h - p^*_f(1 + \phi_b)) \cdot \frac{1}{1 - G(\hat{x})} \cdot (1 - G(\hat{x} + (p_{if} - p^*_f)(1 + \phi_b))) \). Given these demand functions, each seller then maximizes its total profits, where there is a marginal production cost, \( k \geq 0 \), and where the revenue from any foreign buyer is subject to the seller iceberg trade cost, \( \phi_s p_{if} \): \( \pi_i(.) = (p_{ih} - k)D_{ih}(p_{ih}; p^*_f) + (p_{if} - k - \phi_s p_{if})D_{if}(p_{if}; p^*_h, p^*_f) \). When evaluated at equilibrium, i) the FOC with respect to \( p_{if} \) leads to (13) directly, and ii) the FOC with respect to \( p_{ih} \) leads to \( 2p^*_h = k + (\bar{x} - \hat{x}) + (1 + \phi_b)p^*_f \) which after substitution gives (12).

**Claim 3.** Under iceberg trade costs, we can define the border effect measure, \( B \), as

\[
B = D_{ih}(p^*_h; p^*_f) = 1 - G(\hat{x} + p^*_h - p^*_f(1 + \phi_b)) = 1 - G\left( \hat{x} + \frac{k}{2} \left( 1 - \frac{1 + \phi_b}{1 - \phi_s} \right) \right)
\]

(14)

As before, when the (new) explanatory variables, \( c, \phi_b, \) and \( \phi_s \), tend to zero, then (almost) all buyers buy from foreign regions, such that \( B \) converges to zero, but when the explanatory variables become large (such that Condition 1 just fails), then (almost) all buyers buy from their home region such that \( B \) converges to one.

**Claim 4.** Under iceberg trade costs, the marginal effects from an increase in information frictions, \( c \), on the border effect, \( B \), and cross-border trade, \( T = 1 - B \), are larger than the
marginal effects from an increase in the strength of seller trade costs, $\phi_s$, or buyer trade costs, $\phi_b$, when $k$ is sufficiently small.

Using (14), we can state i) $\frac{\partial B}{\partial \phi_b} = \frac{k}{2(\varepsilon - \varepsilon)(1 - \phi_s)}$, ii) $\frac{\partial B}{\partial \phi_s} = \frac{k(1 + \phi_b)}{2(\varepsilon - \varepsilon)(1 - \phi_s)^2}$, and iii) $\frac{\partial B}{\partial c} = -\frac{1}{\varepsilon - \varepsilon}$. It then follows that $\frac{\partial B}{\partial c}$ is greater than $\frac{\partial B}{\partial \phi_b}$ and $\frac{\partial B}{\partial \phi_s}$ when $k$ is sufficiently small.

Claim 5. Under iceberg trade costs, relative to a marginal increase in the strength of seller trade costs, $\phi_s$, or buyer trade costs, $\phi_b$, a marginal increase in information frictions, $c$, leads to a greater increase in seller profits, and a larger reduction in buyer surplus and total welfare, when $k$ is sufficiently small.

First, consider equilibrium seller profits, which can be rewritten as $\pi^*_i = p^*_h B + (p^*_h(1 - \phi_s)(1 - B) - k$. One can verify that $p^*_h > p^*_f(1 - \phi_s)$. Thus, it follows that $\frac{\partial \pi^*_i}{\partial c} > \max\{\frac{\partial \pi^*_i}{\partial \phi_b}, \frac{\partial \pi^*_i}{\partial \phi_s}\}$ if i) $\frac{\partial B}{\partial \phi_b} > \max\{\frac{\partial B}{\partial \phi_b}, \frac{B}{\partial \phi_s}\}$, ii) $\frac{\partial \pi^*_i}{\partial \phi_b} > \max\{\frac{\partial \pi^*_i}{\partial \phi_b}, \frac{\partial \pi^*_i}{\partial \phi_s}\}$, and iii) $\frac{\partial p^*_f(1 - \phi_s)}{\partial c} > \max\{\frac{\partial p^*_f(1 - \phi_s)}{\partial \phi_b}, \frac{\partial p^*_f(1 - \phi_s)}{\partial \phi_s}\}$. Condition i) follows from Claim 3. Condition ii) follows for $k$ sufficiently small with use of (12). Condition iii) follows with use of (13).

Second, consider buyer surplus and denote $C$ as the equilibrium number of searches, and $F$ as the equilibrium number of cross-border transactions. The only possible first-order effects from a marginal change in an explanatory variable, $z$, involve the effects on i) increased prices for given levels of demand, $n\left[\frac{\partial p^*_h}{\partial z} B + \frac{\partial p^*_f(1 - B)}{\partial z}\right]$, ii) increased total resource costs for existing search activity, $C \frac{\partial c}{\partial z}$, and iii) increased total resource costs for existing cross-border transactions, which now equals $F \frac{\partial (\phi_b + \phi_s)p^*_f}{\partial z}$. Information frictions, $c$, then produce the larger total marginal effect when $k$ is sufficiently small. This follows because i) they produce larger marginal effects on both $p^*_h$ in (12) and $p^*_f$ in (13), and ii) because they produce larger resource effects as the equilibrium number of searches, $C$, is strictly larger than the equilibrium number of cross-border transactions, $F$, with $C \frac{\partial c}{\partial z} = \frac{G(x + p^*_h - p^*_f(1 + \phi_b))}{G(x + p^*_h - p^*_f(1 + \phi_b))} > 1$.

Finally, using the text, the proof for total welfare follows immediately as we need only consider the resource effects in ii) above. \qed

References


