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than the Domestic Border Effect?
Evidence from U.S. Trade

Cletus C. Coughlin
Dennis Novy

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Abstract

Many studies have found that international borders represent large barriers to trade. But how do international borders compare to domestic border barriers? We investigate international and domestic border barriers in a unified framework. We consider a unique data set of exports from individual U.S. states to foreign countries and combine it with trade flows between and within U.S. states. After controlling for distance and country size, we estimate that relative to state-to-state trade, crossing an individual U.S. state's domestic border appears to entail a *larger* trade barrier than crossing the international U.S. border. Due to the absence of governmental impediments to trade within the United States, this result is surprising. We interpret it as highlighting the concentration of economic activity and trade flows at the local level.

JEL Code: F10, F15.

Keywords: international border, intranational home bias, domestic border, gravity, trade costs, concentration.

Cletus C. Coughlin
Research Division
Federal Reserve Bank of St. Louis
P.O. Box 442
USA – St. Louis, MO 63166-0442
coughlin@stls.frb.org

Dennis Novy
Department of Economics
University of Warwick
UK – Coventry CV4 7AL
d.novy@warwick.ac.uk

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1. Introduction

In a seminal paper, McCallum (1995) found that Canadian provinces trade up to 22 times more with each other than with U.S. states. This astounding result, also known as the *international border effect*, has led to a large literature on the trade impediments associated with international borders. More recently, Anderson and van Wincoop (2003) revisited the U.S.-Canadian border effect with new micro-founded estimates. Although they are able to reduce the border effect considerably, there is widespread consensus that the international border remains a large impediment to trade.¹

A parallel, smaller literature has documented that border effects also exist within a country, known as the *domestic border effect* or intranational home bias. For example, Wolf (2000) finds that trade within individual U.S. states is significantly larger than trade between U.S. states even after he controls for economic size, distance and a number of additional determinants. Likewise, Nitsch (2000) finds that domestic trade within the average European Union country is about ten times larger than trade with another EU country.²

It is important to understand the nature of domestic and international trade barriers since they might impede the integration of markets and have negative welfare consequences. Accurately identifying the magnitudes of border effects at the domestic and international levels is a necessary step for assessing their economic significance. The contribution of this paper is to merge the two strands of literature about border effects into a unified framework. We construct a unique data set that includes three tiers of U.S. trade flows: a) trade within individual U.S. states, e.g., Minnesota-Minnesota; b) trade between U.S. states, e.g., Minnesota-Texas; and c) trade between U.S. states and foreign countries, e.g., Minnesota-Canada.

We use gravity theory to estimate the relative size of the domestic and international border effects. As is typical in the literature, the domestic border effect indicates how much a U.S. state trades with itself relative to state-to-state trade, while the international border effect indicates how much a U.S. state trades with foreign countries relative to state-to-state trade.

¹ Anderson and van Wincoop (2004) report 74 percent as an estimate of representative international trade costs for industrialized countries (expressed as a tariff equivalent). About two-thirds of these costs can be attributed to border-related trade barriers such as tariffs and non-tariff barriers. The remainder represents transportation costs. While McCallum (1995) compares trade between Canadian provinces and U.S. states to inter-provincial trade, Anderson and van Wincoop (2003) add inter-state trade data.

² An earlier study by Wei (1996) finds similar results for OECD countries. Nikolaus Wolf (2009) finds sizeable domestic border barriers in the historical context for Germany in the late 19th and early 20th centuries. Chen (2004) documents significant intra-European Union border effects at the industry level.

After controlling for distance and country size we find that relative to state-to-state trade, crossing an individual U.S. state's domestic border entails a *larger* trade barrier than crossing the international U.S. border. Put differently, although trading internationally is of course more costly in total than trading intranationally, our results indicate that the estimated increase in trade barriers when leaving the domestic state is relatively larger than the increase associated with leaving the United States.

As an illustrative example, consider exports from Minnesota to Texas and Canada (see Figure 1). Although Texas and Canada have roughly the same gross domestic products, during the year 2002 Minnesota exported about twice as much to Texas as to Canada (\$5.7bn vs. \$2.9bn). This gap would be the familiar international border effect. However, in the same year Minnesota traded over ten times as much with itself as with Texas (\$69.1bn vs. \$5.7bn). This gap would be the domestic border effect, and it is bigger than the international gap, both in absolute and relative terms.³

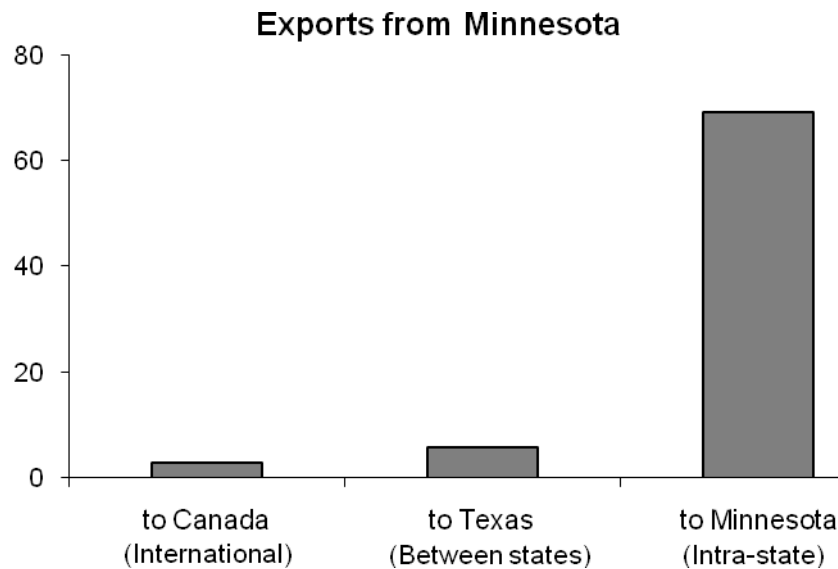


Figure 1: Exports from Minnesota to three destinations. Data for the year 2002 in bn U.S. dollars.

³ Of course, this example ignores the effect of distance and it does not account for economic size. It is merely supposed to serve as an illustration.

What are the economic reasons behind the large domestic border effect? International trade economists traditionally emphasize trade barriers associated with international borders such as tariffs, bureaucratic hurdles and informational barriers. Although beginning with Wolf (2000) and Nitsch (2000) the empirical literature has also demonstrated that borders within a country are associated with a significant trade-impeding effect, it is much harder to think of administrative and informational barriers that coincide with state borders within the same country. Instead, one plausible explanation is related to work by Hillberry and Hummels (2008). Based on ZIP-code level domestic U.S. trade flows, they document that trade within the United States is heavily concentrated at the local level. In particular, trade within a single ZIP code is on average three times higher than trade with partners outside the ZIP code. This concentration might be due to the prevalence of trade in intermediate goods at the local level, arguably as a result of supply chain optimization as companies seek to minimize transportation costs and suppliers co-locate with final goods producers. This high concentration of trade at the local level implies large domestic border barrier estimates. In that interpretation, the estimated domestic border effect does not reflect state border barriers per se but rather local agglomeration effects. But of course, the fact that firms cluster in areas as small as a single ZIP code might be indicative in itself of trade costs associated with relatively short distances. As we discuss in section 5, other reasons for the strong local concentration of trade include informational and search costs, for example in the form of business, social and immigration networks, increasing returns at the local level as well as location-specific tastes.

Given the large literature on border effects it can arguably be seen as a logical extension to estimate international and state border effects in a joint framework so that they can be directly compared. In fact, research by Fally, Paillacar, and Terra (2010) is related to our work. As part of a study examining wage differences across Brazilian states, they estimate a gravity equation in which bilateral trade flows are explained by a set of trade cost variables that include both domestic and international border effects. Consistent with our results for the United States, their estimates imply that the average Brazilian state border has a relatively *larger* negative impact on bilateral trade flows than the international border.⁴

⁴ Other research using different tiers of trade flows includes Poncet (2003) and Hering and Poncet (2010) for Chinese data.

The paper is organized as follows. In section 2 we carefully examine the general equilibrium theory of trade with trade barriers to derive our empirical estimation framework. In section 3 we describe the data set that we use in section 4 to estimate international and domestic border effects. In section 5 we discuss a number of potential explanations for our empirical results. Section 6 concludes.

2. Gravity theory and the estimation framework

2.1 Gravity theory

Gravity equations can be derived from a variety of trade models, such as the gravity framework with multilateral resistance by Anderson and van Wincoop (2003), the Ricardian trade model by Eaton and Kortum (2002), Chaney's (2008) extension of the Melitz (2003) heterogeneous firms model as well as the heterogeneous firms model by Melitz and Ottaviano (2008) with a linear demand system.⁵ To obtain results that are easily comparable to the previous literature on border effects, we adopt the widely used gravity framework by Anderson and van Wincoop (2003). Our results, however, could also be generated with the other frameworks.

Anderson and van Wincoop's (2003) parsimonious model rests on the Armington assumption that countries produce differentiated goods and trade is driven by consumers' love of variety. They derive the following gravity equation for exports x_{ij} from region i to region j :

$$(1) \quad x_{ij} = \frac{y_i y_j}{y^W} \left(\frac{t_{ij}}{\Pi_i P_j} \right)^{1-\sigma},$$

where y_i and y_j denote output of regions i and j , y^W denotes world output, t_{ij} is the bilateral trade cost factor (one plus the tariff equivalent), Π_i is the outward multilateral resistance term and P_j is the inward multilateral resistance term. The parameter $\sigma > 1$ is the elasticity of substitution. The bilateral trade costs t_{ij} capture a variety of trade frictions such as transportation costs, tariffs and bureaucratic barriers and they also include the border barriers.

2.2 The estimation framework

We follow McCallum (1995) and other authors by hypothesizing that trade costs t_{ij} are a loglinear function of geographic distance, $dist_{ij}$, and a border dummy, $INTERNATIONAL_{ij}$, which takes on the value 1 whenever regions i and j are located in different countries. In addition, we

⁵ See Chen and Novy (2008) for an overview.

hypothesize that domestic trade costs within a region's own territory might be systematically different from bilateral trade costs. We therefore include an ownstate dummy variable, $OWNSTATE_{ij}$, that takes on the value 1 for $i=j$. Our trade cost function can thus be expressed as

$$(2) \ln(t_{ij}) = \tilde{\beta} INTERNATIONAL_{ij} + \gamma OWNSTATE_{ij} + \delta \ln(dist_{ij}),$$

where $\tilde{\beta}$ and γ reflect the international and the ownstate (i.e., domestic) border effects, respectively, and δ is the elasticity of trade costs with respect to distance.

The trade cost function (2) nests the trade cost functions used by Wolf (2000), Hillberry and Hummels (2003) and Anderson and van Wincoop (2003). Wolf (2000) and Hillberry and Hummels (2003) only consider trade flows within the U.S. so that an international border effect cannot be estimated. This corresponds to $\tilde{\beta}=0$ in equation (2). Anderson and van Wincoop (2003) follow McCallum's (1995) specification that does not allow for a domestic border effect ($\gamma=0$).

We log-linearize equation (1) so that we obtain

$$(3) \ln(x_{ij}) = \ln(y_i) + \ln(y_j) + (1-\sigma)\ln(t_{ij}) + (\sigma-1)\ln(\Pi_i P_j) + \alpha_t + \varepsilon_{ij},$$

where the logarithm of world output is captured by year dummies α_t and where we add a white-noise error term ε_{ij} . Substituting the trade cost function (2) yields the following estimating equation:

$$(4) \ln(x_{ij}) = \ln(y_i) + \ln(y_j) + \beta INTERNATIONAL_{ij} + \gamma OWNSTATE_{ij} + \delta \ln(dist_{ij}) + (\sigma-1)\ln(\Pi_i P_j) + \alpha_t + \varepsilon_{ij},$$

where $\beta=(1-\sigma)\tilde{\beta}$, $\gamma=(1-\sigma)\gamma$ and $\delta=(1-\sigma)\delta$. In the empirical analysis we control for multilateral resistance by fixed and random effects in various specifications.

2.3 Border effects in theory

The empirical literature typically finds that international borders impede trade. This corresponds to $\beta<0$ in estimating equation (4). Trading within a state is typically associated with higher trade flows, corresponding to $\gamma>0$. We first examine whether gravity theory allows us to predict whether the international border effect β is larger or smaller in absolute value than the domestic border effect γ , i.e., whether $|\beta|\geq|\gamma|$.

As we explain below in more detail, our data set comprises three tiers of trade flows:

- a) ownstate trade: trade flows within a U.S. state, for example within Minnesota, such that $OWNSTATE_{ij}=1$ and $INTERNATIONAL_{ij}=0$,
- b) national trade: trade flows between two U.S. states, for example from Minnesota to Texas, such that $OWNSTATE_{ij}=INTERNATIONAL_{ij}=0$, and
- c) international trade: trade flows from a U.S. state to a foreign country, for example from Minnesota to Canada, such that $OWNSTATE_{ij}=0$ and $INTERNATIONAL_{ij}=1$.

The second tier is thus the omitted category in equation (4), implying that the ownstate border effect is estimated relative to the benchmark of trade between U.S. states. We choose this benchmark to obtain coefficients that are directly comparable to those in the literature (Wolf, 2000; Nitsch, 2000). Therefore, the sign and magnitude of the ownstate border effect can be gauged by comparing trade costs t_{ii} within a typical U.S. state i to bilateral trade costs t_{ij} with another U.S. state j . We draw this comparison by considering their ratio t_{ii}/t_{ij} . Abstracting from any stochastic elements, equations (1) and (2) imply that this ratio is given by

$$\frac{t_{ii}}{t_{ij}} = \left(\frac{x_{ij}}{x_{ii}} \frac{y_i}{y_j} \right)^{\frac{1}{\sigma-1}} \frac{P_i}{P_j} = \frac{\exp(\gamma)(dist_{ii})^{\delta}}{(dist_{ij})^{\delta}}.$$

Using $\gamma = \gamma/(1-\sigma)$ and $\delta = \delta/(1-\sigma)$ this can be rewritten as

$$(5) \quad \exp(\gamma) = \frac{x_{ii}}{x_{ij}} \frac{y_j}{y_i} \left(\frac{P_j}{P_i} \right)^{\sigma-1} \left(\frac{dist_{ij}}{dist_{ii}} \right)^{\delta}.$$

As a simple example, first assume the symmetric case where $y_i=y_j$, $P_i=P_j$ and $dist_{ii}=dist_{ij}$. A positive ownstate effect $\gamma>0$ would follow only if $x_{ii}/x_{ij}>1$. Now assume the more representative case where bilateral distance $dist_{ij}$ exceeds domestic distance $dist_{ii}$. Given that the distance elasticity of trade is negative ($\delta<0$), an even bigger ratio x_{ii}/x_{ij} would be required to ensure $\gamma>0$. More generally, we conclude that given the distance element of trade costs as well as the output and multilateral resistance variables, the sign and magnitude of the domestic border effect parameter γ will primarily depend on the extent of domestic trade x_{ii} relative to bilateral trade x_{ij} .

As in the literature, we also use the benchmark of trade between U.S. states for estimating the international border effect. To gauge its sign and magnitude, we compare bilateral trade costs t_{ik} between a typical U.S. state i and a typical foreign country k to trade costs t_{ij} between two U.S. states. Their ratio is given by

$$\frac{t_{ik}}{t_{ij}} = \left(\frac{x_{ij}}{x_{ik}} \frac{y_k}{y_j} \right)^{\frac{1}{\sigma-1}} \frac{P_k}{P_j} = \frac{\exp(\tilde{\beta})(dist_{ik})^{\tilde{\delta}}}{(dist_{ij})^{\tilde{\delta}}},$$

or

$$(6) \exp(\beta) = \frac{x_{ik}}{x_{ij}} \frac{y_j}{y_k} \left(\frac{P_j}{P_k} \right)^{\sigma-1} \left(\frac{dist_{ij}}{dist_{ik}} \right)^{\delta}.$$

As before, assume the simple symmetric case where $y_k=y_j$, $P_k=P_j$ and $dist_{ik}=dist_{ij}$. A negative international border effect $\beta < 0$ would follow only if $x_{ik}/x_{ij} < 1$. In the more common case where international distance $dist_{ik}$ (say, between Minnesota and Japan) exceeds inter-state distance $dist_{ij}$ (say, between Minnesota and Texas), an even smaller ratio x_{ik}/x_{ij} would be required to ensure $\beta < 0$. Given distances as well as the output and multilateral resistance variables, the international border effect parameter β will therefore mainly depend on the extent of international trade x_{ik} relative to inter-state trade x_{ij} .

Thus, equations (5) and (6) can in principle yield either sign for γ and β . The fact that most empirical studies find $\gamma > 0$ and $\beta < 0$ is consistent with but by no means implied by gravity theory. Neither does gravity theory make a prediction about the absolute magnitudes of β and γ . *A priori* we therefore cannot infer whether $|\beta| \geq |\gamma|$.

3. Data

To obtain comparable results we use the same data sets as Wolf (2000) and Anderson and van Wincoop (2003) for domestic trade flows within the United States. The novelty of our approach is to combine these domestic trade flows with international trade flows from individual U.S. states to the 50 largest U.S. export destinations. Thus, our data set comprises, for instance, trade flows within Minnesota, exports from Minnesota to Texas as well as exports from Minnesota to Canada. We take data quality seriously, and below we describe in detail the data sources, potential concerns and how we address these concerns.

3.1 Domestic exports: Commodity Flow Survey

For our measures of the shipments of goods within and across U.S. states, we use aggregate trade data from the Commodity Flow Survey, which is a joint effort of the Bureau of Transportation Statistics and the Bureau of the Census. We use survey results from 1993, 1997,

and 2002. The survey covers the origin and destination of shipments of manufacturing, mining, wholesale trade, and selected retail establishments. The survey excludes shipments in the following sectors: services, crude petroleum and natural gas extraction, farm, forestry, fishery, construction, government, and most retail. Shipments from foreign establishments are also excluded; import shipments are excluded until they reach a domestic shipper. U.S. export (i.e., trans-border) shipments are also excluded.

3.2 International exports: Origin of Movement

Our data on exports by U.S. states to foreign destinations are from the Origin of Movement series.⁶ These data are compiled by the Foreign Trade Division of the U.S. Bureau of the Census. The data in this series identify the state from which an export begins its journey to a foreign country. However, we would like to know the state in which the export was produced. Below we provide details on the Origin of Movement series and its suitability as a measure of the origin of production.⁷

Beginning in 1987, the Origin of Movement series provides the current-year export sales, or free-alongside-ship (f.a.s.) costs if not sold, for 54 ‘states’ to 242 foreign destinations. These export sales are for merchandise sales only and do not include services exports. The 54 ‘states’ include the 50 U.S. states plus the District of Columbia, Puerto Rico, U.S. Virgin Islands, and unknown. Following Wolf (2000), we use the 48 contiguous U.S. states. Rather than all 242 destinations, we use the 50 leading export destinations for U.S. exports for 2005.⁸ We use the annual data from 1993, 1997 and 2002 for total merchandise exports.⁹

Concerns about using the Origin of Movement series to identify the location of production are especially pertinent for agricultural and mining exports.¹⁰ Cassey (2009) has examined the issue of the coincidence of the state origin of movement and the state of production

⁶ Other studies that have used the Origin of Movement series include Smith (1999), Coughlin and Wall (2003), Coughlin (2004) and Cassey (2011).

⁷ The highlighted details as well as much additional information can be found in Cassey (2009).

⁸ Alphabetically, the countries are Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Costa Rica, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Finland, France, Germany, Guatemala, Honduras, Hong Kong, India, Indonesia, Ireland, Israel, Italy, Japan, Kuwait, Malaysia, Mexico, Netherlands, New Zealand, Norway, Panama, Peru, Philippines, Russia, Saudi Arabia, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, United Arab Emirates, United Kingdom, and Venezuela.

⁹ We have also tried the data for manufacturing only (as opposed to total merchandise). The two series are very highly correlated (99 percent). The regression results are almost identical and we therefore do not report them.

¹⁰ See <http://www.trade.gov/td/industry/otea/state/technote.html>.

for manufactured goods.¹¹ The reason for restricting the focus to manufacturing is that the best source for location-based data on export production, “Exports from Manufacturing Establishments,” covers only manufacturing.¹²

Cassey’s key finding relevant to our analysis is that overall, the Origin of Movement data is of sufficient quality to be used as the origin of the production of exports. Nonetheless, the data for specific states may not be of sufficient quality as the origin of production. These states are: Alaska, Arkansas, Delaware, Florida, Hawaii, New Mexico, South Dakota, Texas, Vermont, and Wyoming. He recommends the removal of Alaska and Hawaii in particular. As we use the 48 contiguous U.S. states, our data set is consistent with this recommendation. The next two candidates for removal would be Delaware and Vermont. Cassey further highlights that the consolidation of export shipments might systematically affect the Origin of Movement estimates (relative to the origin of production). Specifically, consolidation tends to bias upward the estimates for Florida and Texas and to bias downward the estimates for Arkansas and New Mexico. As a robustness check, we drop these states from the sample (see section 4.3).

3.3 Adjustments to the trade data

Our simultaneous use of the intra-state and inter-state shipments data from the Commodity Flow Survey and the merchandise international trade data from the Origin of Movement series requires an adjustment to increase the comparability of these data sets. Such an adjustment arises because of three important differences between the data sources. First, the merchandise international trade data measures a shipment from the source to the port of exit just once, whereas the commodity flow data likely measures a good in a shipment more than once. For example, a good may be shipped from a plant to a warehouse and, later, to a retailer. Second, goods destined for foreign countries, when they are shipped to a port of exit, are included in domestic shipments. Third, the coverage of sectors differs between the data sources. The Commodity Flow Survey includes shipments of manufactured goods, but it excludes agriculture and part of mining. Meanwhile, the merchandise trade data includes all goods.⁹

Identical to Anderson and van Wincoop (2003), we scale down the data in the Commodity Flow Survey by the ratio of total domestic merchandise trade to total domestic

¹¹ For the initial work on this issue, see Coughlin and Mandelbaum (1991) as well as Cronovich and Gazel (1999).

¹² The data in the “Exports from Manufacturing Establishments” is available at <http://www.census.gov/mcd/exports/> but does not contain destination information, so it cannot be used for the current research project.

shipments from the Commodity Flow Survey. Total domestic merchandise trade is approximated by gross output in the goods-producing sectors (i.e., agriculture, mining, and manufacturing) minus international merchandise exports.¹³ This calculation yields an adjustment factor of 0.495 for 1993, 0.508 for 1997 and 0.430 for 2002.¹⁴ Similar to Anderson and van Wincoop (2003), our adjustment to the commodity flow data does not solve all the measurement problems, but it is the best feasible option.

3.4 Other data

The rest of the data used in our estimations can be characterized as well-known. We use export data from the International Monetary Fund's *Direction of Trade Statistics* for flows between the 50 foreign countries. For individual U.S. states we use state gross domestic product data from the U.S. Bureau of Economic Analysis. For foreign countries, we use data on gross domestic product taken from the IMF World Economic Outlook Database (October 2007 edition).

We use the standard great circle distance formula to cover inter-state and international distances between capital cities in kilometers. As intra-state distance, we use the distance between the two largest cities in a state. As alternatives for intra-state distance, we also try the measure used by Wolf (2000) that weights the distance between a state's two largest cities by their population, as well as the measure suggested by Nitsch (2000) that is based on land area. Finally, we also use a distance measure that is related to actual shipping distances, based on data for individual shipments used by Hillberry and Hummels (2003), see section 4.3 for details.

4. Empirical results

We form a balanced sample over the years 1993, 1997 and 2002. This yields 1,801 trade observations per cross-section within the U.S.¹⁵ Adding 50 foreign countries as export destinations increases the number of trade observations by 2,338 so that our sample includes

¹³ See Helliwell (1997, 1998) and Wei (1996).

¹⁴ The difference between our adjustment factor for 1993 and that of Anderson and van Wincoop, 0.495 vs. 0.517, is due to data revision.

¹⁵ The maximum possible number of U.S. observations would be $48 \times 48 = 2,304$. The 503 missing observations are due to the fact that a number of Commodity Flow Survey estimates did not meet publication standards because of high sampling variability or poor response quality.

4,139 observations per cross-section, or 12,417 in total.¹⁶ Recall that due to the data quality concerns as well as for consistency reasons Alaska, Hawaii and Washington, D.C. were dropped, so we use the 48 contiguous U.S. states.

First, we show that our data exhibit a substantial domestic border effect, as established by Wolf (2000). In separate regressions, we also show that the data exhibit a significant international border effect, as established by McCallum (1995). Second, we combine the domestic U.S. trade data with the international observations. This allows us to estimate the domestic and international border effects jointly and to directly compare their magnitudes. Finally, we carry out a number of robustness checks.

4.1 Domestic and international border effects estimated separately

In columns 1 and 2 of Table 1 we show results that replicate the intranational home bias. For comparison with Wolf (2000) who uses a sample for 1993, in column 1 we only use data for that year. In column 2 we add the data for 1997 and 2002. Like Hillberry and Hummels (2003) we use exporter and importer fixed effects so that the output regressors drop out. Our point estimates in columns 1 and 2 (1.46 and 1.48) are virtually identical to Wolf's baseline coefficient of 1.48 for the ownstate indicator variable. The interpretation of this coefficient is that given distance and economic size, ownstate trade is 4.4 times higher than state-to-state trade ($\exp(1.48) = 4.4$).

Hillberry and Hummels (2003) reduce the ownstate coefficient by about a third when excluding wholesale shipments from the Commodity Flow Survey data. The reason is that wholesale shipments are predominantly local so that their removal disproportionately reduces the extent of ownstate trade.¹⁷ However, Nitsch (2000) reports higher home bias coefficients by comparing trade within European Union countries to trade between EU countries. He finds home bias coefficients in the range of 1.8 to 2.9.

¹⁶ The maximum possible number of international observations would be $48 \times 50 = 2,400$. Sixty-two observations are missing mainly because exports to Malaysia were generally not reported in 1993. Only 18 of the observations not included in our sample are most likely zeros (as opposed to missing).

¹⁷ We do not have access to the private-use coding of wholesale shipments and thus cannot replicate their finding with our data. However, our main results in Table 2 on the relative size of the domestic and international border effects is qualitatively robust to a reduction by a third in the ownstate coefficient magnitudes. Hillberry and Hummels (2003) further reduce the ownstate coefficient by using an alternative distance measure that is based on actual shipping distances. We refer to section 4.3 where we employ such a measure, but our main result is unchanged.

In columns 3 and 4 we do not consider ownstate trade but rather focus on the international border effect. These regressions use the sample of 50 foreign countries. In column 3 we estimate an international border coefficient of -1.19 for the year 1993, implying that after we control for distance and economic size, exports from U.S. states to foreign countries are about 70 percent lower than exports to other U.S. states ($\exp(-1.19) = 0.30$). This coefficient is somewhat lower in magnitude than the estimate of -1.65 obtained by Anderson and van Wincoop (2003) with trade data between U.S. states and Canadian provinces. When we pool the data over the years 1993, 1997 and 2002 in column 4, the border effect is estimated at -1.04. Estimation in that column is carried out with random effects since fixed effects at the country level would be collinear with the international border dummy variable.

Overall, we conclude that we obtain estimates for domestic and international border effects in Table 1 that are consistent with the literature.

4.2 Is the international border effect larger than the domestic border effect?

In Table 2 we turn to estimating the domestic and international border effects jointly so that their magnitudes are directly comparable. For this purpose, we simultaneously use domestic and international trade flows, while continuing to use inter-state trade as the reference group as in Table 1. When we pool the data over the years 1993, 1997 and 2002 in column 2, we add random effects instead of country fixed effects. The reason is again that country fixed effects would be perfectly collinear with the ownstate and international dummy variables. Exporter and importer fixed effects would also be impractical because of collinearity with the international border dummy.¹⁸

Columns 1 and 2 show that the ownstate coefficients are estimated at 2.04 and 2.05, while the international coefficients are estimated at -1.24 and -1.10. The hypothesis that the two border coefficients in each column are equal in absolute magnitude is clearly rejected (p -value = 0.00). Thus, a key finding in Table 2 is that the domestic border effect is larger in absolute magnitude than the international border effect. That is, relative to inter-state trade, crossing an individual U.S. state's domestic border is estimated to entail a *larger* trade barrier than crossing the international U.S. border.

¹⁸ The collinearity arises because the foreign countries in our data set are only importers but never exporters.

Another observation is that the joint estimation in Table 2 yields substantially different estimates of the domestic border effect. The coefficient on $OWNSTATE_{ij}$ is 1.48 when estimated separately (see Table 1, column 2), and 2.05 when estimated jointly (see Table 2, column 2). Note that the distance coefficient in those columns changes from -1.07 to -0.82, and the latter value is close to the distance coefficients in columns 3 and 4 of Table 1. Likewise, the income elasticities are also similar to those estimated in columns 3 and 4 of Table 1. It can therefore be argued that given the parameter estimates for the gravity equations involving international trade flows, the extent of ownstate trade appears even bigger.

4.3 Robustness

Various authors, such as Helliwell and Verdier (2001) and Head and Mayer (2009), have pointed out that the estimation of border effects is sensitive to how distance is measured. For example, if the relevant economic distance within a U.S. state is much shorter than indicated by conventional measures—perhaps because economic activity is highly concentrated in two nearby cities—then it might no longer be surprising if a state trades considerably more within its boundaries than with partners further away. To address this concern we employ three alternative distance measures that have been suggested in the literature.

Column 1 of Table 3 uses the alternative measure for ownstate distance proposed by Wolf (2000). This measure weights the distance between a state's two largest cities by their population. It thus better reflects heavy concentration of economic activity in relatively small areas. For example, most economic activity in Utah is concentrated around Salt Lake City such that the conventional great circle distance measure could easily overstate actual shipping distances. As expected, on average this alternative measure results in shorter ownstate distances (109 km vs. 179 km) so that it reduces the domestic border effect compared to Table 2. In particular, the coefficient on $OWNSTATE_{ij}$ declines from 2.05 (Table 2, column 2) to 1.64 (Table 3, column 1). Despite the smaller magnitudes of the domestic border effect, it is still significantly different from the absolute value of the international border estimate in column 1 of Table 3 (the p-value is 0.02). Also note that compared to column 2 of Table 2, the result for the international border effect in column 1 of Table 3 is virtually the same (-1.13 compared to -1.10). A similar observation can be made concerning the distance coefficient.

In column 2 of Table 3 we employ a measure of ownstate distance that is based on land area as in Nitsch (2000). His measure is based on a hypothetical circular economy with three equal-sized cities, one in the center and the other two on opposite sides of the circle. The average internal distance of such an economy, and also other economies with more complex structures, can be approximated by the radius of the circle. In the data this is computed as $1/\sqrt{\pi}$ = 0.56 times the square root of the area in km^2 , and on average this results in roughly similar ownstate distances (170 km vs. 179 km). Nevertheless, the ownstate dummy estimate increases slightly to 2.23 compared to 2.05 in column 2 of Table 2.

In column 3 we employ a third alternative distance measure that is closer to actual shipping distances by ground transportation observed within the United States. Based on private-use Commodity Flow Survey data at the ZIP code level, Hillberry and Hummels (2003, equation 4 and Table 1) provide a statistical relationship between the distance measure used by Wolf (2000), an ownstate dummy and an adjacency dummy. They estimate the following equation:

$$(7) \ln(\text{actual } dist_{ij}) = \lambda_1 \ln(\text{Wolf } dist_{ij}) + \lambda_2 \text{OWNSTATE}_{ij} + \lambda_3 \text{adjacency}_{ij} + e_{ij}$$

with $\lambda_1 = 0.821$, $\lambda_2 = -0.498$ and $\lambda_3 = -0.404$. We use these coefficients to approximate actual shipping distances within the United States as well as to Canada and Mexico, and we then use them as an explanatory variable. The resulting distances are on average considerably shorter compared to the great circle distances, both within U.S. states (18 km vs. 179 km) as well as between U.S. states and to Canada and Mexico (450 km vs. 1556 km). The distances to overseas countries are not affected as those routes are not covered by ground transportation. In column 3 of Table 3, both border coefficients are reduced in magnitude to 1.50 from 2.05 for the ownstate coefficient and to -0.24 from -1.10 for the international coefficient compared to column 2 of Table 2. But note that the absolute difference between the coefficients remains highly significant.

Results for additional robustness checks are reported in the remaining columns of Table 3. Hillberry and Hummels (2008) document that trade is highly concentrated at the local level and that it consists to some extent of local wholesale shipments. In column 4 we provide results for trade between locations that are not within immediate proximity to limit the potential influence of wholesale shipments. In particular, we drop all state-to-state observations that are less than 200 miles apart to check whether they distort the sample. This check removes 100 cross-sections from the panel. Nonetheless, the regression results are virtually the same as in

column 2 of Table 2. We obtain similar results if we also drop all within-state observations less than 200 miles apart (not reported here).

As we explain in section 3.2, Cassey (2009) raises doubts as to whether the Origin of Movement data are sufficiently similar to the actual origin of production in the case of Delaware, Vermont, Florida, Texas, Arkansas, and New Mexico. In column 5 we drop these six states from our sample. Once again, the regression results are overall quite similar to those in Table 2.

In column 6 we follow Wolf (2000) by adding an adjacency dummy that takes on the value 1 whenever two states are neighboring (say, Minnesota and Wisconsin). Similar to Wolf (2000), we find that adding an adjacency dummy reduces the ownstate coefficient. Nevertheless, the domestic border effect remains stronger in absolute value than the international border effect. However, in column 6 we can no longer reject the hypothesis that their absolute values are equal (p -value = 0.30).

Overall, we conclude that although the point estimates of the domestic and international border effects can change depending on the distance measure and subsample we use, it is a robust feature of the data that the absolute magnitude of the domestic border effect exceeds that of the international border effect. Their difference is highly significant in almost all specifications.

5. Discussion

We discuss a number of potential explanations for our empirical result that the domestic border effect is comparatively large in magnitude. One major explanation is related to work by Hillberry and Hummels (2008). Based on ZIP-code level domestic U.S. trade flows, they document that trade within the United States is heavily concentrated at the local level: trade within a single ZIP code is on average three times higher than trade with partners outside the ZIP code. As a major reason they point out the co-location of producers in supply chains to exploit informational spillovers, to minimize transportation costs and to facilitate just-in-time production.¹⁹ The local concentration of trade might also be related to external economies of scale in the presence of intermediate goods and associated agglomeration effects (see Rossi-Hansberg, 2005), as well as to hub-and-spoke distribution systems and wholesale shipments (see

¹⁹ Historically, competition on U.S. state-to-state transportation routes was heavily restricted by the Interstate Commerce Commission well into the post-World War II era, giving companies an additional incentive to co-locate (see Levinson, 2006).

Hillberry and Hummels, 2003). Such spatial clustering of economic activity can lead to large domestic border barrier estimates, as we find in our results.²⁰ In that case, the domestic border effect should be interpreted as reflecting the local concentration of economic activity rather than border barriers associated with crossing a state border.

The concentration of trade at the local level is also borne out in other types of data. Using individual transactions data from online auction websites, Hortaçsu, Martínez-Jerez and Douglas (2009) find that purchases tend to be disproportionately concentrated within a short distance perimeter, with many counterparties based in the same city. Some of these purchases can be explained by their location-specific nature, for example in the case of opera tickets. But the evidence also suggests that lack of trust and lack of direct contract enforcement in case of breach may be major reasons behind the same-city bias, which the authors subsume under ‘contracting costs.’ They also find evidence for culture and local tastes as factors that shape the local concentration of trade. For example, the same-city effect is most pronounced for local interest items such as sports memorabilia (also see Blum and Goldfarb, 2006).

Business networks and immigration patterns might also be related to strong trade flows between relatively close locations. Combes, Lafourcade and Mayer (2005) report that business and immigrant networks significantly facilitate trade within France. They cite the reduction of information costs and the diffusion of preferences as two main economic mechanisms through which networks may operate. This includes the reduction of search costs associated with matching buyers and sellers (Rauch and Casella, 2003). As an additional facilitating factor for trade, Rauch and Trindade (2002) also mention the possibility of community sanctions that could be imposed amongst members of an ethnic network. In the context of the border effect in U.S. data, Millimet and Osang (2007) find that incorporating migration flows within the U.S. diminishes the estimated intranational home bias. Business and immigrant networks therefore likely play an important role in explaining the trade-reducing effect of distance.²¹

²⁰ The concentration of trade at the local level might also be related to firms’ slicing up their production chains (multi-stage production and vertical specialization). Yi (2010) offers an explanation of the border effect using the vertical specialization argument in a Ricardian framework.

²¹ The impact of ethnic networks on exports from U.S. states has been explored recently by Bandyopadhyay, Coughlin and Wall (2008). One of their findings is that the inclusion of a common network effect reduces the negative impact of distance on exports.

6. Conclusion

We collect a data set of U.S. exports that combines three types of trade flows: trade within an individual state (Minnesota-Minnesota), trade between U.S. states (Minnesota-Texas) and trade flows from an individual U.S. state to a foreign country (Minnesota-Canada). This data set allows us to jointly estimate the effect on trade of crossing the domestic state border and the effect of crossing the international border.

While we obtain point estimates consistent with those generally found in the literature, we show that the international border effect is in fact *smaller* than the state border effect. That is, while trading internationally is still the most costly in absolute terms, overcoming the first few miles that are associated with leaving the home state appears harder than crossing the international border once the home state has been left. This result is robust to alternative distance measures and different subsamples. Our paper thus sheds new light on the relative size of border effects as typically estimated in gravity applications. In particular, our finding of a relatively strong domestic border effect can be interpreted as reflecting the concentration of economic activity and trade flows at the local level.

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Table 1: Domestic and international border effects, estimated separately

Sample Year	U.S. only		U.S. and 50 countries	
	1993 (1)	1993, 1997, 2002 (2)	1993 (3)	1993, 1997, 2002 (4)
$\ln(y_i)$			1.29** (0.02)	1.22** (0.02)
$\ln(y_j)$			0.83** (0.01)	0.83** (0.01)
$\ln(\text{dist}_{ij})$	-1.08** (0.03)	-1.07** (0.03)	-0.86** (0.03)	-0.85** (0.03)
OWNSTATE_{ij}	1.46** (0.20)	1.48** (0.19)		
$\text{INTERNATIONAL}_{ij}$			-1.19** (0.06)	-1.04** (0.05)
National trade (reference group)	yes	yes	yes	yes
Ownstate trade	yes	yes	no	no
International trade	no	no	yes	yes
Observations	1,801	5,403	4,091	12,273
Clusters	--	1,801	--	4,091
Fixed effects	yes	yes	no	no
R-squared	0.90	0.90	0.79	0.78

Notes: The dependent variable is $\ln(x_{ij})$. OLS estimation. Robust standard errors are reported in parentheses, clustered around country pairs ij in columns 2 and 4. Exporter and importer fixed effects in columns 1 and 2, time-varying in column 2; random effects in column 4. Constants and year dummies are not reported. ** significant at 1% level.

Table 2: Domestic and international border effects, estimated jointly

Sample Year	U.S. and 50 countries	
	1993 (1)	1993, 1997, 2002 (2)
$\ln(y_i)$	1.28** (0.02)	1.21** (0.02)
$\ln(y_j)$	0.82** (0.01)	0.82** (0.01)
$\ln(\text{dist}_{ij})$	-0.83** (0.03)	-0.82** (0.03)
OWNSTATE_{ij}	2.04** (0.20)	2.05** (0.20)
$\text{INTERNATIONAL}_{ij}$	-1.24** (0.06)	-1.10** (0.05)
$ \text{OWNSTATE}_{ij} = \text{INTERNATIONAL}_{ij} $	[0.00]	[0.00]
National trade (reference group)	yes	yes
Ownstate trade	yes	yes
International trade	yes	yes
Observations	4,139	12,417
Clusters	--	4,139
Random effects	no	yes
R-squared	0.79	0.79

Notes: The dependent variable is $\ln(x_{ij})$. OLS estimation. Robust standard errors are reported in parentheses, clustered around country pairs ij in column 2. Random effects in column 2. Constants and year dummies are not reported. ** significant at 1% level. The numbers in brackets report p-values for the test $|\text{OWNSTATE}_{ij}| = |\text{INTERNATIONAL}_{ij}|$.

Table 3: Robustness checks

Sample Years: 1993, 1997, 2002	U.S. and 50 countries			U.S. and 50 countries		
	(1)	(2)	(3)	Distance > 200 m. (4)	Fewer states (5)	Adjacency (6)
$\ln(y_i)$	1.21** (0.02)	1.21** (0.02)	1.21** (0.02)	1.22** (0.02)	1.21** (0.02)	1.21** (0.02)
$\ln(y_j)$	0.81** (0.01)	0.82** (0.01)	0.79** (0.01)	0.82** (0.01)	0.81** (0.01)	0.81** (0.01)
$\ln(\text{dist}_{ij})$: Wolf (2000)	-0.80** (0.03)					
$\ln(\text{dist}_{ij})$: Nitsch (2000)		-0.84** (0.03)				
$\ln(\text{dist}_{ij})$: Actual shipping distance			-0.76** (0.02)			
$\ln(\text{dist}_{ij})$				-0.81** (0.03)	-0.78** (0.03)	-0.65** (0.03)
adjacency _{ij}						1.11** (0.07)
OWNSTATE _{ij}	1.64** (0.22)	2.23** (0.17)	1.50** (0.20)	2.08** (0.20)	2.03** (0.22)	1.48** (0.19)
INTERNATIONAL _{ij}	-1.13** (0.06)	-1.06** (0.05)	-0.24** (0.07)	-1.10** (0.06)	-1.21** (0.06)	-1.28** (0.06)
$ \text{OWNSTATE}_{ij} = \text{INTERNATIONAL}_{ij} $	[0.02]	[0.00]	[0.00]	[0.00]	[0.00]	[0.30]
National trade (reference group)	yes	yes	yes	yes	yes	yes
Ownstate trade	yes	yes	yes	yes	yes	yes
International trade	yes	yes	yes	yes	yes	yes
Observations	12,417	12,417	12,417	12,117	10,368	12,417
Clusters	4,139	4,139	4,139	4,039	3,456	4,139
Random effects	yes	yes	yes	yes	yes	yes
R-squared	0.78	0.79	0.79	0.78	0.79	0.79

Notes: The dependent variable is $\ln(x_{ij})$. OLS estimation. Robust standard errors are reported in parentheses, clustered around country pairs ij . Random effects in all columns. Constants and year dummies are not reported. ** significant at 1% level. The numbers in brackets report p-values for the test $|\text{OWNSTATE}_{ij}| = |\text{INTERNATIONAL}_{ij}|$. Column 4 drops all pairs of U.S. states that are less than 200 miles apart. Column 5 drops states with inferior data quality (AR, DE, FL, NM, TX, VT). Column 6 adds an adjacency dummy that is one if two regions have a land border.

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