THE IMPACT OF TRANSPORTATION COSTS AND TRADE BARRIERS ON INTERNATIONAL TRADE FLOWS

by

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DISSERTATION ABSTRACT

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Because trade is seen as welfare improving for society, governments have long employed their policy-making powers to increase trade levels. In recent years, no strategy has been more employed by policy makers than free trade agreements. As free trade agreements become more popular, world tariff levels rapidly approach zero. Given this, policy makers must look to other methods to encourage trade. I examine how non-tariff trade barriers impact international trade levels. By better understanding these trade barriers, policy makers will be able to make more informed decisions.

To better understand non-tariff trade barriers, I begin with well-known impediments to trade, including the border effect, transportation costs, and the trade creation and trade diversion effects of regional trade agreements. I then demonstrate and examine heterogeneity in these trade costs.

In Chapter II I examine the often-studied border effect, the notion that regions trade more intra-nationally than internationally. I demonstrate that smaller regions are less attractive to foreign trading partners than their larger counterparts. Fixed costs of crossing an international border, as well as more effective marketing methods, mean economically larger U.S. states or Canadian provinces see a smaller border effect. In Chapter III I look at how transportation costs incurred within the exporting country impact trade levels. Using a unique instrumental variable strategy, I show that the cost of getting a good to a port is a significant hindrance to trade. Finally, in Chapter IV I show that the benefits of joining the European Union are heterogeneous across countries. This means that while the E.U. may be beneficial on average, it may not be beneficial for individual countries.

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For my parents. Thank you for being the best parents a person could ever hope to have.

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CHAPTER I

INTRODUCTION

Because trade is seen as welfare improving for society, governments have long employed their policy-making powers to increase trade levels. In recent years, no strategy has been more employed by policy makers than free trade agreements. As free trade agreements become more popular, world tariff levels rapidly approach zero. Given this, policy makers must look to other methods of encouraging trade. I examine how non-tariff trade barriers impact international trade levels. By better understanding these trade barriers, policy makers will be able to make more informed decisions.

To better understand non-tariff trade barriers, I begin with well-known impediments to trade, including the border effect, transportation costs, and the trade creation and trade diversion effects of regional trade agreements. I then demonstrate and examine heterogeneity in these trade costs.

Chapter II, titled "Market Size and Heterogeneity of Border Effects in Gravity Models of Trade," examines the impact of importer market size on the border effect. The border effect is the idea that Canadian provinces trade more with other Canadian provinces than they do with U.S. states after controlling for distance and other relevant variables. Because distance controls for transportation costs, the border effect should represent fixed costs of crossing the U.S.-Canada border. When selling to a larger market, the per-unit value of these fixed costs is necessarily lower which makes a larger market a more attractive export destination. In addition, per-person marketing costs are likely lower for economically larger regions as large cities make reaching customers easier. I estimate the impact of importer size on the border effect by estimating the standard gravity model and include an interaction between the border effect and importer size. I find that a 10% increase in importer market size leads to a 2.6% increase in international trade relative to intra-national trade. This result is robust to a variety of specifications, including non-linear estimation.

Chapter III, titled "Differing Trade Elasticities for Intra- and International Distances: a Gravity Approach," focuses on the importance of internal trade costs in exporting items internationally. The gravity model literature typically proxies for trade costs by included a between-country distance variable. While this serves as a good proxy for trade costs incurred in shipping a good from one country to another, it does not capture the trade costs incurred before a good leaves the country. I estimate the effect of these internal trade costs by creating a measure of internal distance, the distance a good travels before exiting the United States. In addition, I use two different identification strategies to correct for the potential endogeneity bias created by firms being able to pick their production location. I find that the internal trade costs are a more important determinant of trade than external transportation costs.

Chapter IV is titled "Trade Creation and Trade Diversion in the European Union: Do Larger Countries Benefit More?" and focuses on the border effect of the European Union. I begin by estimating the average trade creation and trade diversion effects of joining the European Union. Then, by estimating these effects for each member country, I demonstrate that the benefits and costs of joining the European Union are heterogeneous across countries. I further explore potential causes of this heterogeneity. I show that one cause of heterogeneous trade creation and trade diversion effects is importer and exporter market size. In addition, various natural country groups such as Scandinavian and Eastern Bloc countries face differing results of joining the European Union.

Each chapter focuses on a different non-tariff trade barrier, but they ultimately seek to accomplish the same goal. Lowering tariffs is no longer a practical trade-creating policy tool. By looking at well known trade costs, and explaining precisely how these trade costs impact trade levels, I seek to create a better informed policy maker. A complete understanding of the border effect allows policy makers to focus on lowering the fixed costs of crossing the U.S.-Canadian border. By knowing that internal transportation costs are a larger hindrance to trade than between country transportation costs, policy makers should set as their main priority improving the country's transportation infrastructure. Through fully understanding trade costs, this dissertation seeks to allow for better-informed trade policy.

CHAPTER II

MARKET SIZE AND HETEROGENEITY OF BORDER EFFECTS

Introduction

The gravity model is one of the most successful empirical models employed in the trade literature. It does a remarkable job of predicting the direction and volume of trade. One particularly interesting empirical regularity found with the application of the gravity model is the border puzzle, which Obstfeld and Rogoff (2001) call one of the six major puzzles of international economics. Stated simply, controlling for relevant factors, regions are significantly more likely to trade with other regions within their country than with regions outside the home country.

Since McCallum (1995) found that Canadian provinces have an alarmingly high propensity to trade with other provinces, as compared to U.S. states, *ceteris peribus*, trade economists have set out to explain this "border puzzle." A seminal work on the subject is Anderson and van Wincoop (2003), which finds that while the border puzzle still remains, when properly specifying the model used in the border effect literature the magnitude is much smaller than previously thought.

In this paper, I contribute to the border effect literature in two key ways. First, I demonstrate that the border effect is heterogeneous across states and provinces and suggest one potential cause of this heterogeneity: economically larger regions may have significantly smaller border effects because the costs associated with crossing the Canada-U.S. border are fixed, meaning the per-unit impact of these costs are smaller for larger importing markets. My second major contribution to the border effect literature is that I formalize this "market size" effect both theoretically and empirically, showing that importer market sizes positively affect international trade more than intranational trade, even after accounting for multilateral resistance terms. In addition, I show that a region's population density is a significant determinant of its border effect. These empirical results are derived through the use of a unique data set which includes all U.S. states, something the previous literature frequently fails to consider. I briefly demonstrate that the exclusion of small states by prior studies leads to a biased estimate of the border effect.

This paper proceeds as follows. In the next section I briefly review the literature on gravity, border effect, and market size. In section three I discuss the theoretical implications of transportation costs being a function of importer size. In the fourth section, I describe the data used in the paper. In section five I demonstrate the sampling bias present in previous border effect papers as well as individually estimate each region's border effect. I find heterogeneous border effects and list potential causes for this result. In section six, I test for the presence of the market size effect. In section seven, I perform a variety of robustness checks. The eighth section concludes.

Literature Review

Since Tinbergen (1962) developed the gravity model of trade, it has been an empirical work horse for international trade economists. Though economists have been using the gravity model since the 1960s, it stood only on its empirical success until Anderson (1979), when it gained theoretical justification. Now, more than thirty years after Anderson (1979) and more than fifty years after its introduction, trade economists still use the gravity model to understand the size, direction, and causes of bilateral trade flows.

One important use of the gravity model has been to explain the importance of trade costs. In Anderson and van Wincoop (2004), the authors explain that trade costs, especially non-policy trade costs, continue to be large. Taylor, Robindeaux, and Jackson (2004) argues that transportation costs at the United States-Canadian border costs the countries $10.3 billion annually. Disdier and Head (2008) demonstrates that despite market globalization, the distance effect continues to persist in trade. Hillberry and Hummels (2008) shows that trade costs reduce the extensive margin of trade, so exporters ship less varieties, with little impact on the per-unit value of the goods shipped. On the other hand, Chaney (2008) and Helpman, Melitz and Rubinstein (2008) develop models that show both the intensive and extensive margins changing with trade costs.

McCallum (1995) employs the gravity model to examine what has become known as the border puzzle. In the paper, McCallum uses a standard gravity model to examine trade between Canadian provinces and U.S. states or other provinces, adding only a dummy variable to indicate if the trade is from one province to another. The author finds that, holding other relevant variables constant, trade between two Canadian provinces is more than twenty times larger than trade between that same province and an otherwise identical U.S. state. While it is not particularly unexpected that a province is more inclined to trade with another province, the magnitude of the border effect was quite surprising and led to considerable follow-up research attempting to explain the magnitude.

One potential explanation of the border effect is that a border dummy variable is proxying for tariffs or other trade policies. However, Wolf (2000) shows that state borders matter within the United States, implying that the border effect must be proxying for more than just U.S. trade policy. Wolf (2005) finds a similar result in Poland. Hillberry and Hummels (2003) demonstrates that the Wolf (2000) result is driven by wholesaling, while Millimet and Osang (2007) shows that controlling for past levels of trade can explain the state home bias. I demonstrate a different factor in determining the border effect: importer market size.

Likely the most well known follow-up to McCallum (1995) is Anderson and van Wincoop (2003). In their paper, Anderson and van Wincoop develop a structural specification for the model McCallum employs, something missing from the original paper. This theoretical justification makes clear that the McCallum paper suffers from omitted variables bias. Specifically, the equation should include what Anderson and van Wincoop call a "multilateral resistance" variable which captures the notion that bilateral trade depends not only on the prices of the two regions involved, but also the prices of all outside options. Through a demanding econometric methodology, the authors construct multilateral resistance terms, allowing them to estimate the border effect consistently and efficiently. While they do find a sizable border effect of roughly 20% to 50%, this number is considerably smaller than the effect discovered in McCallum (1995). Another key aspect of Anderson and van Wincoop (2003) is the inclusion of state to state trade, which McCallum had omitted. This allows the authors to examine the border effect going from Canada to the United States and compare it to the effect of moving from the United States to Canada. They find that the border effect is much more pronounced for Canadian provinces than for U.S. states.[1]

Anderson and van Wincoop (2003) is not without its critics, however. In Santos Silva and Tenreyro (2006), the authors show that using Poisson Quasi-Maximum Likelihood estimation techniques yield very different results than one would get using log-linear specifications, as both McCallum and Anderson and van Wincoop do. I use this as a robustness check to my log-linear

[1] There also exists a considerable literature examining the border effect using price data, such as Engel and Rogers (1996), Parsley and Wei (2000), and Gorodnichenko and Tesar (2009).

specifications. By examining the proportions of trade costs paid by buyers and sellers, Anderson and Yotov (2010) demonstrates that the previous border effect literature suffers from a downward bias of the border effect variable.

In Balistreri and Hillberry (2007), the authors argue that the Anderson and van Wincoop assumption of symmetric trade costs is inappropriate. In addition, the authors argue that the inclusion of U.S. to U.S. trade data is the only driving force behind the Anderson and van Wincoop result. Using Anderson and van Wincoop's structural model without state to state trade alters the McCallum border effect estimate very little, implying that perhaps Anderson and van Wincoop have not found a "solution" to the border puzzle. In essence, Balistreri and Hillberry (2007) show that Anderson and van Wincoop's (2003) estimates suffer from a sampling bias. Similarly, Matsuo and Ishise (2012) add the missing U.S. states to the Anderson and van Wincoop sample to document that this exclusion generates sampling bias. My analysis provides an explanation for the small state sampling bias; I show that this bias can be explained by the fixed-cost portion of crossing the border resulting in a smaller per-unit impact of the border on larger markets. An incomplete working paper, Coughlin and Novy (2011), also demonstrates a size-based omitted variable bias. However, the authors do not explore the connection to marketing costs as I do in this paper but assume it comes from aggregation bias.

In Redding and Venables (2004), the authors construct a model of trade that yields a gravity equation that contains exporter and importer fixed effects. Along a similar track, Feenstra (2002) estimates the border effect gravity equations three different ways: using published price indexes, using the methods outlined in Anderson and van Wincoop (2003), and including exporter and importer fixed effects. Feenstra concludes that the fixed effect methodology produces consistent estimates of the average border effect, while simultaneously being much easier to implement than the Anderson and van Wincoop (2003) methodology, and thus could be considered the preferred methodology for estimating border effects. I use this methodology to account for the multilateral resistance terms in sections six and seven. In "*Bonus vetus* OLS," Baier and Bergstrand (2009) use a Taylor-series expansion to arrive at a consistent method of estimating gravity models without the econometric rigor of the Anderson and van Wincoop specification. This methodology has the added benefit of allowing for comparative statics, which cannot be done in the Feenstra (2002) specification.

Recently, Dias (2011b) argues that the trade cost component of the gravity equation should best be estimated using a polynomial function that would allow distance to enter the gravity equation in a way not typically employed in the literature. This determination follows from the author developing a model of trade based on Eaton and Kortum (2002), which Dias modifies to include FDI and the idea that some trade costs may vary with distance while others may not. In Dias (2011a), the author argues that an interaction between the border dummy and distance should be added to the typical gravity equation. In addition, the author argues linear estimation techniques bias the border effect upward and that non-linear estimation techniques must be used. Lastly, the author argues that by including the interaction between the border dummy and distance, the McCallum (1995) border effect disappears, indicating distance matters more for international trade than it does for intra-national trade. I show that the market-size effect is present even after controlling for differing distance effects.

My paper is also related to an extensive literature on how both importer and exporter market sizes impact trade patterns. Exporter market sizes are often linked to trade through a supply-side story. A seminal paper on the subject is Krugman (1980). In this paper, Krugman creates a model with transportation costs and economies of scale in production. These assumptions drive the "market size" effect, which says that locations with a larger market for a good are more likely to be exporters of that good. Campbell and Hopenhayn (2005) demonstrate a positive relationship between area population, which they use as a measure of market size, and average firm size. Combining this with Bernard and Jensen (1999), who demonstrate that larger firms tend to export, and the resulting implication is that there is a positive relationship between exporter market size and exporting. However, none of these papers relate any market size effect to the border effect, as I do in this paper.

There are also papers discussing the impact of importer market size on trade. One such paper, Eaton, Kortum and Kramarz (2005), shows that the fixed costs of entering a market as outlined in Melitz (2003) and Chaney (2008) are an important determinant of the relationship between market size and firm entry. Another paper is Arkolakis (2010). Arkolakis creates a model using the general framework of Melitz (2003) and Chaney (2008), adding a"marketing cost." The cost of reaching a certain number of consumers is assumed to be decreasing in the market's population size while reaching the next customer in a given market is increasing in cost.

This allows Arkolakis to reconcile trade models with the finding of Eaton, Kortum, and Kramarz (2011) that the number of exports to a given market is positively associated with the size of the market. In contrast to these papers, I am taking the further step of linking importer market size to the magnitude of the border effect.

Theoretical Framework

There exist fixed costs of crossing the border between the United States and Canada. These can include delays in clearing customs or fees associated with understanding regulatory requirements for crossing the border. Indeed, in 1993 (the year of my data), with the Canada-United States Free Trade Agreement well into its life, there likely are very few variable costs associated with crossing the Canadian-U.S. border. As such, these fixed costs could potentially explain much of the border effect. In addition, because these costs are fixed, the costs being spread across more goods implies that the costs have a smaller impact on larger markets. I call this effect, in the border effect context, the "market size effect." Thus, the border effect could be explained in part by the importer market size.

I develop a model that highlights why this market-size effect on the border is important to capture. I adapt a model by Eaton and Kortum (2002), explicitly making trade costs a function of importer market size. This allows for very different outcomes when employing comparative statics. The model outlined in Eaton and Kortum (2002) is well suited as a framework for my empirical model developed below, as it results in an empirically testable gravity equation, and it does so by allowing for multiple regions to produce homogeneous, rather than differentiated goods.

The Eaton and Kortum (2002) model is one of Ricardian trade, where firms have access to differing technologies. There is a continuum of goods $k \in [0, 1]$, region i's efficiency in producing k is denoted by $z_i(k)$, the cost of a bundle of inputs is region - but not good - specific, and is labeled c_i, and there are constant returns to scale. This results in a cost of producing good k in region i of $\frac{c_i}{z_i(k)}$.

Region i's efficiency (or technology) at producing good k, $z_i(k)$, is assumed to be a random draw from a region-specific probability distribution $F_i(z) = Pr[z_i \leq z]$. By the law of large numbers, $F_i(z)$ is the fraction of goods in region i whose efficiency is less than z. As in Eaton and Kortum (2002), I assume that the distribution of efficiencies in a region follows a Fréchet distribution, so that

$$F_i(z) = e^{-T_i z^{-\theta}} \tag{2.1}$$

where $T_i > 0$ is the location of the distribution and can be thought of as the state of technology in region i, and θ is the variation in the distribution. The variable θ is assumed the same for all regions. A larger T_i implies a higher probability of a larger efficiency draw for any good k. A higher θ implies less variation in the distribution. Thus, according to Eaton and Kortum, T_i governs a region's absolute advantage, while θ governs its comparative advantage.

Trade costs follow the typical iceberg assumption. That is, delivering one unit of a good from exporter region i to importer region j requires producing and shipping d_{ij} units of the good, where d_{ij} is referred to as trade costs. A few underlying assumptions about the trade cost component are that $d_{ii} = 1$ so that there are no internal trade costs, that $d_{ij} > 1 \ \ \forall i \neq j$ so that there are positive external trade costs and that the triangle inequality holds so that $d_{ij} < d_{im}d_{mj}$.

To reflect that trade costs may be a function of importer market size, I adapt the Eaton and Kortum (2002) model to explicitly make the trade cost parameter a function of importer market size, denoted Y_j, but not exporter market size, so that trade costs are equal to $d_{ij}(Y_j)$. The effects of this are immediate. While Eaton and Kortum themselves do not assume identical trade costs (in other words, that $d_{ij} = d_{ji}$), many empirical specifications of the gravity equation do rely on this assumption. However, in this model, except in the highly unlikely case that $Y_i = Y_j \ \ \forall i \neq j$, it is extremely unlikely that the assumption of identical trade costs will hold.[2] Note that I am not assuming that the trade costs are *solely* determined by importer market size, so it need not be the case that $d_{ij} = d_{mj}$. For simplicity and clarity, I write the trade cost variable as d_{ij}.

Combining the discussion of trade costs, input costs, and efficiency described above, one arrives at a price of good k in region j that is purchased from region i:

$$P_{ij}(k) = \left(\frac{c_i}{z_i(k)}\right) d_{ij} \tag{2.2}$$

[2]It is technically possible for the trade costs to be identical, so that $d_{ij} = d_{ji}$ even if it is not the case that $Y_i = Y_j \ \ \forall i \neq j$. This can be true if any other relevant variable for determining trade costs between partners vary in a way that exactly offsets the differing size effect. However, while it may be probable for a few trade pairs to have the same trade costs in either direction, it remains highly unlikely for *all* trade pairs.

The model is one of perfect competition, so the price actually paid in region j for good k can be written as:

$$P_j(k) = min\left\{P_{ij}(k); i = 1, ..., N\right\} \tag{2.3}$$

where N is the total number of regions, including region j. Consumers buy $Q(k)$ amounts of good k in order to maximize the CES utility function

$$U = \left[\int_0^1 Q(k)^{(\sigma-1)/\sigma}\, dk\right]^{\frac{\sigma}{\sigma-1}} \tag{2.4}$$

subject to the budget constraint that the total spending in region j is equal to Y_j, where $\sigma > 0$ is the elasticity of substitution.

Substituting equation 4.2 into equation 2.1 yields the following distribution of prices from region i to region j:

$$G_{ij}(p) = Pr[P_{ij} \leq p] = 1 - F_j(c_i d_{ij}/p) \tag{2.5}$$

$$G_{ij}(p) = 1 - e^{-[T_i(c_i d_{ij})^{-\theta}]p^{\theta}} \tag{2.6}$$

If the lowest price at which region j can purchase a good is from purchasing domestically, they will do so. Thus, the lowest price in region j will be less than the domestic price p so long as at least one region, m, satisfies the constraint $p_{mj} < p$. This implies that the distribution of goods region j imports, $G_j(p)$ is given by:

$$G_j(p) = 1 - \prod_{i=1}^{N}[1 - G_{ij}(p)] \tag{2.7}$$

Substituting equation 2.6 into equation 2.7 then gives:

$$G_j(p) = 1 - e^{-\Phi_j p^{\theta}} \tag{2.8}$$

where $\Phi_j = \sum_{i=1}^{N} T_i \left(c_i d_{ij}\right)^{-\theta}$. As Eaton and Kortum note, Φ_j, which they call the price parameter, is an important component of trade analysis because it shows how world technological levels T_i, world input costs c_i, and geographic trade barriers d_{ij} impact the prices for any given region j. Remembering that because d_{ij} is a function of importer market size Y_j, Φ_j is also determined by Y_j.

Eaton and Kortum (2002) note an important result from this analysis. The probability that region i is the lowest cost supplier of a good is given by:

$$\pi_{ij} = \frac{T_i \left(c_i d_{ij}\right)^{-\theta}}{\Phi_j} \tag{2.9}$$

Due to the assumption of a continuum of goods, this also represents the fraction of goods that j buys from i. Calling Y_j region j's total spending and X_{ij} the amount of spending in region j on goods from region i, this yields:

$$\frac{X_{ij}}{Y_j} = \frac{T_i \left(c_i d_{ij}\right)^{-\theta}}{\Phi_j} = \frac{T_i \left(c_i d_{ij}\right)^{-\theta}}{\sum_{k=1}^{N} T_k \left(c_k d_{kj}\right)^{-\theta}} \tag{2.10}$$

By noting that region i's total sales, Q_i is given by:

$$Q_i = \sum_{m=1}^{N} X_{im} = T_i c_i^{-\theta} \sum_{m=1}^{N} \frac{d_{im}^{-\theta} Y_m}{\Phi_m} \tag{2.11}$$

solving for $T_i c_i^{-\theta}$, and substituting these into equation 2.11 gives an expression for the sales from region i to region j analogous to the typical gravity equation:

$$X_{ij} = \frac{\left(\frac{d_{ij}}{P_j}\right)^{-\theta}}{\sum_{m=1}^{N} \left(\frac{d_{im}}{P_m}\right)^{-\theta} Y_m} Y_j Q_i \tag{2.12}$$

Note that exporter sales Q_i and importer purchases, Y_j, can be thought of as exporter and importer GDP. As with Anderson and van Wincoop (2003), the exporter GDP enters the equation with unit elasticity. In addition, the trade between region i and region j depend on world price levels, not just the price levels of the two regions involved. Recall that d_{ij}, the trade costs of shipping from i to j, are a function of the importer GDP, which is equivalent to Y_j. Thus, while Y_j enters by itself as a multiplicative term with unit elasticity, trade between i and j also depends on Y_j through trade costs; thus, Y_j does not necessarily have unit elasticity.

This equation is able to highlight the bias generated by ignoring the market size effect when estimating a gravity equation. To show this, I hold the expression $\sum_{m=1}^{N} \left(\frac{d_{im}}{P_m}\right)^{-\theta} Y_m$ constant. Because the gravity model here is not a model over time, this term, which can be thought of as the multilateral resistance term, will be constant for each given region. This can also be thought of as the small region assumption, such that no state or province is large enough to impact the price index. Thus, taking the derivative of equation 2.12 with respect to Y_j yields:

$$\frac{\partial X_{ij}}{\partial Y_j} = \frac{\left(\frac{d_{ij}}{P_j}\right)^{-\theta} Q_i}{\sum_{m=1}^{N}\left(\frac{d_{im}}{P_m}\right)^{-\theta} Y_m} - \frac{\theta\left(\frac{d_{ij}}{P_j}\right)^{-1-\theta} Q_i Y_j \left(\frac{\partial d_{ij}}{\partial Y_j}\right)}{\sum_{m=1}^{N}\left(\frac{d_{im}}{P_m}\right)^{-\theta} Y_m} \tag{2.13}$$

The first component of this derivative is the part typically captured by gravity specifications. However, the second component is typically ignored by omitting trade cost d_{ij}'s dependence on importer market size Y_j. Because d_{ij} is a per unit cost and fixed costs of the market are likely present, I assume $\left(\frac{\partial d_{ij}}{\partial Y_j}\right) < 0$, or that a larger importing market faces lower per-unit trade costs (through, for example, a more developed and efficient infrastructure); this means that typical gravity estimation is underestimating the impact of importer market size on trade flows. In section six, I correct for the omitted variable bias inherent in the previous border effect specifications.

Data

This paper uses inter-regional trade data for all ten Canadian provinces and fifty U.S. states in the year 1993. The primary data used for this analysis comes from three primary sources. These include Statistic Canada's Input-Output Division, the Canadian International Merchandise Trade Database, and the U.S. Census Bureau. Interprovincial merchandise trade data for the year 1993 is provided online by Anderson, and comes from the interprovincial merchandise trade from Statics Canada's Input-Output (IO) Division.

Province-to-state and state-to-province trade data comes from the Canadian International Merchandise Trade Database.[3] McCallum (1995) modified these numbers using trade ratios and the IO trade numbers, while Anderson and van Wincoop (2003) follow Helliwell (1998) in making the same adjustment at a more detailed industry level. I have opted to not make these adjustments, with the minor exception of Anderson and van Wincoop's "rest of U.S." observation, which I leave as constructed in their data. I drop all intra-regional trade observations in this paper. To keep all state trade numbers comparable, I use the unadjusted trade numbers for all

[3] This database can be located at http://www5.statcan.gc.ca/cimt-cicm/home-accueil?lang=eng

states, including those originally in the McCallum and Anderson and van Wincoop specifications. All trade numbers are converted to 1993 U.S. dollars.

The 1993 Commodity Flow Survey (CFS), conducted by the U.S. Census Bureau, provides within-state and state-to-state trade numbers for the year 1993. The reported trade numbers are then scaled down by a factor of 3,025/5,846 for consistency with Anderson and van Wincoop (2003). This scaling was performed by Anderson and van Wincoop for three reasons. First, while the Canadian trade data contains only shipments from source to final user, the CFS data contains all shipments. In addition, goods intended to be exported but first shipped domestically are included in the CFS data. Lastly, the CFS data does not include agriculture or parts of mining that are included in the Canadian data. This scaling methodology is not without its detractors. See, for example, Balistreri and Hillberry (2007).

Of the 3600 trading pairs in the sample, 297 are excluded from the log-linear regressions; 73 pairs are excluded because the value of exports from one partner to the other is zero, so when the value of trade is logged these become undefined. These pairs are included in the non-linear estimations presented. The other 224 are excluded because there is not sufficiently reliable data on trade from the relevant origin to the relevant destination. Of these 297 omitted pairs, 114 have either Alaska or Hawaii as one of the partners and would be omitted from the 48 state specifications anyway. Other exporting regions that omit more than 10% of their partners are Kentucky, Louisiana, North Dakota, Oregon, Rhode Island, West Virginia, and Wyoming.

Distances between interprovincial pairs, interstate pairs, and province-to-state pairs were taken from Anderson, who used kilometer greater circle distances from each regions' capital. The gross product of Canadian provinces were taken from Statistics Canada. Gross state products for U.S. states were taken from the Bureau of Economic Analysis.[4]

Empirical Evidence of Systematic Heterogeneity in Border Effects

Reasons for Modifying the Anderson and van Wincoop Sample

In McCallum (1995), only thirty states and ten Canadian provinces are included in the data set. A list of states excluded in McCallum can be found in Table 1 (see Appendix for all tables). McCallum notes that these thirty states make up 90% of Canada-USA trade in the

[4]GSP can be located at http://www.bea.gov/newsreleases/regional/gdp_state/1998/gsp_0698.htm

year he examined. Desiring to remain comparable with McCallum, Anderson and van Wincoop (2003) also used only thirty states, though they constructed a “rest of U.S.” observation from the additional twenty states and the District of Columbia. As such, much of the literature on border effects has been written without incorporating the full set of states in the United States.

This omission of certain states potentially results in sampling bias. McCallum’s sample includes only those states that border Canada or are the largest, by economic size, in the United States. Table 1 lists those states omitted from McCallum’s sample. Trade theory (and indeed the gravity equation itself) says that these states should have systematically higher trade numbers with Canadian provinces than those excluded from the sample. I begin by examining if adding these twenty states significantly impacts border effect estimates using a gravity equation that uses importer and exporter fixed effects to control for multilateral resistance terms.

I estimate the gravity model using the Anderson and van Wincoop sample, which adds state to state trade to the McCallum sample, using only the 30 states included in the paper and a “rest of U.S.” composite y. I also estimate the gravity equation using all 48 states.[5] To estimate these equations, I follow Feenstra (2002), who demonstrates that importer and exporter fixed effects control for multilateral resistance effects. As such, I estimate the following equation:

$$\ln\left(\frac{X_{ij}}{Y_iY_j}\right) = \beta_4 \ln d_{ij} + \beta_5 \delta^{ij} + \alpha_i + \alpha_j + \epsilon_{ij} \tag{2.14}$$

where δ^{ij} is a dummy variable equal to unity if the region i is a province and region j is a state, or vice versa, and α_i and α_j are exporter and importer fixed effects respectively. Note here that δ^{ij} is a dummy variable indicating international trade.

Table 2 reports the results of the Anderson and van Wincoop specifications. The first column reports the results for equation 2.14 using the original sample of thirty states and ten provinces. Column 2 reports the specification with all fifty states, and column 3 removes Hawaii

[5] Alaska and Hawai’i are excluded for peculiarities other than size, as is typical in much of the state trade literature.

and Alaska from the specification. All variables are statistically significant at the 1% level and the border effect is negative in all specifications.

It is important to note that Feenstra estimates an average effect of 4.7, while column 1 of Table 2 indicates an effect of 6.4 ($e^{1.866}$). This effect is also greater than that of Anderson and van Wincoop (5.2). This is likely due to the trade data being unadjusted in these specifications (though adjusted in Anderson and van Wincoop and Feenstra). Comparatively, the 48 state specification has an average border effect of 7.46 ($e^{2.009}$). This number is higher than the thirty state specification; it represent a 16.5% increase in the border effect. This suggests that by excluding the 18 states I have added to the specification, Anderson and Van Wincoop underestimated the border effect. However, it should be noted that the 48-state specification does not result in a magnitude as high as that of the McCallum specification.

It is also important to test if the 48-state specification is statistically significantly different from the 30-state specification. To do this, I estimated the equation including all variables in equation 2.14 as well as each of those variables (including the fixed effects) interacted with a dummy variable equal to unity if the observation was present in the old sample only. Column 4 of Table 2 reports the results of this significant test. Both the distance effect and the border effect are significantly different from the thirty state specification at the 1% significance level. The positive sign and large magnitude of the coefficient for the border dummy interacted with the in-original-sample dummy indicates that the border effect is much more substantial for the 18 added states than it is for the thirty included states, implying heterogeneous border effects. These results provide strong evidence that a sampling bias is introduced by excluding the smaller 18 states resulting in an underestimation of the border effect, thus verifying the results found in Matsuo and Ishise (2012), among others. For the remainder of this paper I use the 48 state sample.

Heterogeneous Border Effects

Before demonstrating the market size effect discussed in the theoretical model, I first examine whether regions have differing border effects. To estimate individual region border effects, I estimate the following equation for each state and province[6], restricting either i or j to be equal to the region of interest:

$$\ln\left(\frac{X_{ij}}{Y_i Y_j}\right) = \beta_4 \ln d_{ij} + \beta_5 \delta^{ij} + \epsilon_{ij} \qquad (2.15)$$

where X_{ij} is the exports from region i to region j, Y_i is the gross product of region i, d_{ij} is the distance from region i to region j, and δ_{ij} is a dummy variable equal to unity if region i is located in a different country than region j. Thus, to estimate Texas' border effect, I estimate equation 2.15 for each observation in which Texas is an importer *or* an exporter.

Note that this is equation 2.14, but without the fixed effects. The fixed effects are excluded due to concerns about degrees of freedom. For this reason, I do not claim to have precisely measured each region's border effect. Instead, I only use these measures to examine patterns in region-specific border effects. Later, I estimate market size effects on the border effect using the full sample where I can employ exporter and importer fixed effects to properly control for multilateral resistance.

Table 3 reports coefficients on the border dummy, the standard errors of these estimates, and the border effects for each of the 48 U.S. states, where the border effect is calculated as $e^{|\text{Border Coefficient}|}$. Table 4 reports these same estimates for all ten Canadian provinces. All estimated border coefficients are negative and all are statistically significant at the 10% level or greater except for Michigan and Minnesota, which are negative but statistically insignificant.

The first thing to note is that the border effects for the Canadian provinces are significantly larger in magnitude than those of the United States, with the smallest border effect for a

[6]I do not estimate individual border effects for Hawaii or Alaska and also excluded these observations in the calculation of other regions' border effects.

Canadian province being more than double the largest border effect of any U.S. state. This is consistent with AvW's finding that the border has a larger impact on the smaller country.

However, even within Canada there is significant variation in the border effects. British Columbia (BC) has the lowest border effect of any Canadian province with 11.48, meaning BC is eleven times more likely to trade with a Canadian province than a U.S. state, controlling for the effects of gross product and distances. Prince Edward Island has the largest border effect of all Canadian provinces (and indeed, all regions) with an unrealistic 114.01. In Figure 1 (see Appendix for all figures), I depict the pattern of border effects for Canadian provinces.

There is also considerable heterogeneity in the border effects of the states, with border effects ranging from 1.29 to 5.88. Michigan has the smallest border effect, though its border is not statistically significantly different from one. The same is true of Minnesota, with an estimated border effect of 1.62. It is interesting to note that both of these states border Canada. New Mexico has the largest border effect of any U.S. state, estimated to be 5.88. In Figure 2, I show the pattern of border effects for U.S. states.

One pattern of interest is that larger states generally have smaller border effects. For example, note that Texas and Florida (two of the states with the smallest border effect) are among the top five gross state products, whereas Montana (with a very high border effect) has the fourth lowest gross state product of all states. New York and Illinois are in the top five in gross state product and also have relatively small border effects. On the Canadian side, Prince Edward Island has a far larger border effect than any other Canadian province. Its gross product is also only one fourth of the second smallest province by gross product. One potential anomaly to this explanation, however, is the state of California. Despite the fact that California has more gross product than any state or province in the sample, the impact of the border on trade with Canada is significantly high. One potential explanation for this anomaly is that California trades heavily with Mexico and as such does not rely on Canadian trade as much as other states. Another potential anomaly is North Dakota, which has the lowest gross product of all included states, but the border has little impact on its trade with Canada.[7]

There are many potential causes of this size-dependent border effect heterogeneity. One potential reason that larger regions tend to show smaller border effects is the omitted variable bias discussed in Anderson and van Wincoop (2003). The larger a region, the smaller the multilateral resistance term for that region. If multilateral resistance terms are positively correlated with a border effect, the omission of importer and exporter fixed effects (and thus the multilateral resistance term) from equation 2.15 would show larger regions having smaller border effects. All specifications in section six and seven of this paper correct for this bias by including importer and exporter fixed effects.

Another potential cause of the heterogeneity is that tariffs may impact different regions in different ways. For example, a large Canadian tariff on corn production is likely to have a larger effect on Nebraska or Iowa, which produce large amounts of corn, than Florida, which produces very little corn. While I believe this is an important potential cause of the heterogeneity, my data do not contain industry-level trade and as such I am unable to test this. I leave this potential avenue of border effect heterogeneity for future research.

Dias (2011a) argues for an interaction between distance and the border dummy, but given Figure 2 this cannot be the complete story. The argument is that international transportation is different from domestic transportation in such a way that distance matters more to international trade. This would be the case if international shipping is less competitive than intranational shipping. While most of the low-border effect states do tend to be in New England or the Midwest, which are close to the Canadian provinces, Texas and Florida have small border effects despite their distance from Canada; similarly, Montana, which actually borders Canada, is among the highest border effect states. I include a test of this potential avenue of heterogeneity in my

[7]It should be noted that of the potential trading partners in the sample, trade from North Dakota to 8 of the partners are omitted due to zero trade values or insufficient data. Exports from 15 partners to North Dakota are omitted for the same reason. Thus, North Dakota's puzzling border effect could be caused by omitted observations.

econometric specifications, though it should be noted that Dias (2011a) finds no such effect using OLS.

As mentioned in the theory section, while the multilateral resistance terms are likely one part of the explanation for border effect heterogeneity, the "market size effect" is also an important plausible explanation of size-dependent border effect heterogeneity. In the next section, I disentangle these two effects by including importer and exporter fixed effects to correct for multilateral resistance terms while also including an interaction between the border effect dummy and importer market size to help explain the market size effect.

Market Size and the Border Effect: Empirical Results

To examine the issues discussed in the previous section, I run three new gravity specifications, all of which are built on the baseline regression model given by equation 2.14. I first add to equation 2.14 an interaction of the dummy variable and the log of distance in an attempt to replicate Dias (2011a). In another specification, I add an interaction of the border dummy and the log of gross product of the importing state or province. Lastly, I add both interactions into one equation. As such, my preferred specification is:

$$\ln\left(\frac{X_{ij}}{Y_iY_j}\right) = \beta_1 \ln d_{ij} + \beta_2\delta^{ij} + \beta_3\delta^{ij} \times \ln d_{ij} + \beta_4\delta^{ij} \times \ln Y_j + \alpha_i + \alpha_j + \epsilon_{ij} \qquad (2.16)$$

The results of these specification are found in Table 5. Column 1 contains the results of the specification that includes 48 states and no interaction terms and is included for comparison. In column 2, I report the specification that includes the interaction of distance and the border dummy. In column 3, I report the specification which includes the interaction of the border dummy and the log of the importer's gross product. Lastly, column 4 reports the inclusion of both interaction terms as to avoid potential omitted variable bias. Note that all results mentioned below are contingent on trade occurring between the two regions. This is caused by the log-linearization of the model.

In column 3, I test the market-size effect on the border. Column 3 demonstrates that gross product impacts the measure of the border effect. Significant at the 1% level, the larger the economy of a trading partner, *ceteris paribus*, the smaller the effect the border has on trade. Specifically, a 10% increase in the total size of an importing state or province would result in a 2.6% increase in international trade beyond the same market size increase's impact on intranational trade. The last column acts as a robustness check, demonstrating that this market-size effect is robust to the inclusion of the distance-border interaction that Dias (2011a) highlights as being important.[8] The market-size interaction term remains significant at the 1% level (the distance interaction is significant at the 10% level) and the coefficient estimates, while smaller in both cases, are nearly the same as when only one interaction term is include. Thus, I conclude that market size has a larger positive effect for cross-border trade than it does for intranational trade.

In Figure 3 I present a graphical representation of the implied border effect as derived from Table 5 column 3. That is, the thick solid line in Figure 3 is:

$$\text{bordereffect}_i = -4.880 + 0.256 \times \ln Y_i \tag{2.17}$$

The graph brings to light several interesting results. First, the thin solid line represents the mean log of importer market size, which is equal to 11.03057. This implies a border effect of -1.913, which is very close to the -2.009 estimated in column 1 of Table 5. Prince Edward Island (the dashed line), which is the smallest economy in the sample, has an implied border effect of -2.89, while California (the dashed-dotted line), the largest economy in the sample, has an implied

[8] It should be noted here that I actually find that distance has a larger impact on intranational trade than it does international trade. This is contrast to the results of Dias (2011a). Column 4 demonstrates that these conflicting results are not driven by the inclusion of the GDP interaction term. However, it is plausible that distance impacts international trade less than intranational trade, as I find. This would be consistent with the idea of a fixed cost of crossing the border.

border effect of only -1.21, significantly smaller than even that of the average border effect. Perhaps the most important result demonstrated on this graph is the dotted line, the size the importer would need to be such that there would be no border effect. The log of importer GDP, in millions, would have to be 18.142. Thus, for a state or province to have no border effect it would have to have an economy of $75 trillion dollars, or nearly ninety times the 1993 California economy. Thus, for no plausible region size will the border effect completely disappear.

In the above analysis, I use the interaction of the market size and the border effect to proxy for a possible effect of fixed costs in crossing the border. However, marketing costs, MC_{ij}, are likely a function of variables beyond just economic size of importer Y_j. However, there are other marketing costs that may impact the border effect. For example, Arkolakis (2010) allows for the possibility that it is less costly to market to regions with a larger population. To estimate this potential effect, I include an interaction between the border dummy and importer logged population density. I use population density, rather than population count, because populations are not uniformly distributed within regions. One million people concentrated in a region the size of Rhode Island would likely be much easier to reach with marketing than the same million people spread across Montana.

The results for these estimations are reported in Table 6. The first column reproduces the most diverse specification from Table 5. Column two adds the importer population density interaction, which demonstrates the impact of ease of marketing on the border effect. The first important result is that importer population density has a statistically significant positive effect. According to column two, a 10% increase in the population density of an importer will increase international trade to that region by 1.35% more than intranational trade. This indicates that population-density based marketing costs are an important determinant of the border effect. It is also important to note that while the magnitude of the market size effect (the interaction of the border dummy and the log of importer market size) has changed, the magnitude is not statistically significantly different than that found in column one. As such, both region economic size and population density of a region are important determinants of that region's border effect.

Robustness Checks

As mentioned in the previous section, there are many potential explanations for the observed geographical patterns of individual border effects. In this section, I perform a variety of robustness checks to assure the reader that the importer market size effect is not simply proxying for some other cause of heterogeneous border effects. I begin by adding exporter market size into the specification and by adding a coastal region dummy variable to the specification. I conclude this section by performing non-linear estimations of the gravity equation.

Exporter Market Size

One potential concern is that importer market size may be highly correlated with any potential exporter market size effect. The idea that home market demand makes a country more likely to export a good is a well known concept in the trade literature and is commonly referred to as the home market effect (see Krugman 1980). Transportation costs make it more costly to export a good than to sell it locally, so a competitive advantage is given to producers of a good near the market that demands it. If a larger population results in higher demand for a good, exporter market size could have a positive impact on trade totals, which may differ when crossing a border.

To test for this possibility, I run the regression including both an interaction between importer market size and the border dummy and an interaction between exporter market size and the border dummy. The results can be found in column 2 of Table 7. The importer market size interaction is robust to the inclusion of the exporter market size interaction. The importer market size effect is still significant at the 1% level and positive. In addition, the magnitude is functionally the same. The exporter market size interaction enters the specification positively and statistically at the 1% level. The regression shows that a 10% increase in exporter market size will increase trade with international partners by 1.59% more than it would increase intranational trade. This result is quite interesting. Given the extensive home bias literature, it is no surprise that exporter market size is an important factor in determining trade. However, the result that this home bias has a larger impact on international trade is a new one. One potential explanation of this would be the presence of increasing returns to scale. If the producers of a good face increasing returns to scale, higher domestic sales potentially makes these producers better able to overcome any fixed or variable costs of crossing a border.

Coastal States

By noting that Texas and Florida, along with much of the Northeastern United States, in particular have very low border effects, one may think that having access to a coast, and thus ocean transportation, may have an impact on the border effect. To allow for this potentiality, I include in column 3 of Table 7 a dummy variable equal to one if the importing state has an ocean coast and a dummy variable equal to one if the exporting region is on the coast. Even with the inclusion of these dummy variables, the market size interaction is still statistically significant and positive and the magnitude is mostly unchanged.

An importing country having a coastal border has a statistically and economically negative impact on trade. While this result may seem counterintuitive, it is likely caused by the fact that this is an examination of trade specifically between the United States and Canada. Coastal access would have little impact on the transportation costs between states and provinces but would have a large impact on the transportation costs from European and Asian countries. As such, these foreign countries may crowd out trade with coastal states and provinces without having a similar impact on the internal regions. The exporter coastal dummy also enters statistically significant and negative, but has a much smaller magnitude. Note that the inclusion of these coastal variables greatly reduces the magnitude of the border effect before the correction for market size. It could be the case that when properly correcting for coastal access, there is a significantly smaller border effect between the United States and Canada; however, this result could also be driven by the data-generating process resulting in the misrecording of the origin or destination of a good. Further research is necessary to see if coastal access can explain much of the border effect.

In column 4 of Table 7 I include the two coastal dummy variables mentioned above as well as an interaction between these dummy variables and the border dummy to see if coastal access impacts intranational trade differently than international trade. The first thing to note is that the market size effect is still statistically significant and has roughly the same magnitude. Neither of the coastal interaction terms enter with statistical significance. From this I conclude that coastal access does not have a differing impact if trade crosses the U.S.-Canada border.

Non-linear Least Squares

Another potential concern is that the importance of importer market size on the border effect is simply driven by misspecification. Santos Silva and Tenreyro (2006) have observed that misspecifying the gravity equation as linear biases the coefficient estimates of any gravity regression. They demonstrate that non-linear techniques, such as Poisson Quasi-Maximum Likelihood, result in non-biased coefficient estimates. Dias (2011a) demonstrates that log-linearizing the border effect equation results in border effect estimates that are biased upward. In this section I estimate the impact of importer market size on the border effect using two different non-linear estimation techniques.

Since Santos Silva and Tenreyro (2006), Poisson Quasi-Maximum Likelihood (PQML) has become the preferred estimation method for any gravity equation. In Table 8, I report each of the results of using PQML to estimate the impact of importer market size on the border effect. Columns 4 and 5 indicate that the importer market size interaction term loses significance when I move to a PQML estimation. However, in this specification the standard errors have become significantly large. For example, the standard error of the border dummy in column 5 is more than ten times larger than the same coefficient's standard error in column 1. Indeed, the border effect itself seems to have disappeared! This is likely caused by multicolinearity. Because there are significantly more intranational trade observations than international trade observations, the border dummy variable is highly correlated with the market size interaction. As such, I interact the market size with $(1 - \text{border effect})$ in column 6.

The market size effect is statistically significant at the 1% level and moves in the same direction as the log-linearized specification.[9] In addition, the magnitude in the PQML estimation is more than double that of the log-linear estimation, indicating the log-linear estimation's importer market size effect is a conservative estimate. It should also be noted that the sign on the distance interaction switches signs, and is now consistent with Dias (2011a).

While PQML is the most common estimator used in the recent border effect literature, it does have its drawbacks. Specifically, it assumes that the mean and standard deviation are equal to each other. To be sure this is not impacting the results, I also estimate the equations using a negative binomial estimator. These results are found in Table 9. The coefficient estimates are nearly identical to those found in the PQML estimations.

Conclusion

The "home bias" or "border effect" puzzle has been a striking empirical oddity since McCallum (1995). Trade economists have long attempted to explain the magnitude of the border effect through a variety of econometric and theoretical techniques; perhaps the most successful example is Anderson and van Wincoop (2003), which explains much of the magnitude of the border effect as being the result of omitted variables bias.

In this paper, I demonstrate another important omitted variable in the estimation of home bias: the importer market size's impact on the border effect. I develop a model based on Eaton

[9] Because it is now interaction with $(1 - \text{border effect})$, the negative sign is now the same as a positive sign in the log-linear equation.

and Kortum (2002) in which trade costs are explicitly a function of importer market size. I then empirically demonstrate the existence of heterogeneous border effects. From these results, I provide a mechanism, fixed costs of crossing the border, that potentially explains why larger markets would experience a smaller border effect.

With this, I empirically estimate how the border effect is impacted by importer market size. I find that a 10% increase in the market size of an importing country would increase trade by 2.6% more for cross border trade, thus mitigating the border effect. In addition, importer population density, proxying for marketing costs, also are important in determining the border effect. I finish the paper by performing robustness checks to strengthen my result. From these robustness checks I conclude that importer market size does in fact have a significant impact on the border effect.

CHAPTER III

INTERNAL TRANSPORTATION COSTS AND INTERNATIONAL TRADE

Introduction

International trade economists have long been interested in trade costs. In recent years, as artificial trade barriers, such as tariffs and quotas, fall to low levels, trade economists have become more interested in transportation costs as a trade barrier. Because they are difficult to measure, many trade models proxy for these trade costs with distances between countries. While the distance between countries, which I call external distance, functions well as a proxy for trade costs (and has since Tinbergen 1962), it does not give an explicit explanation of trade costs. In addition, it fails to capture anything not correlated with external distance.

Because of this limitation, there is a significant literature that attempts to explicitly define trade costs (see for example Anderson and van Wincoop 2004). Transportation costs can be anything from actual shipping costs to time delays associated with shipping (Hummels and Schaur 2013) to uncertainty associated with maritime piracy (Burlando et al. 2014). The trade cost literature includes examinations of free trade agreements (Baier and Bergstrand 2007), culture (Rauch and Trindade 2002), historical and political costs (Head et al. 2010), and the border effect (McCallum 1995, Anderson and van Wincoop 2003) among many others.

One potentially important trade cost that has received little attention until recently is the costs incurred in trading before a good leaves the country of origin, which I call internal costs (see Agnosteva et al. 2014). One probable avenue in which internal costs are important is that a firm located in a country with high internal costs is at a competitive disadvantage compared to those firms that can move a good through its location cheaper. While we have many estimates for the effect of external distance on trade, we know very little about the magnitude of internal distance as a hindrance to international trade.

Little research has been done in this area because internal trade costs and internal distance can be both extremely difficult to measure and difficult to estimate. No comprehensive data set exists that allows a researcher to perfectly track the movements of a traded good within the country of origin. To overcome this obstacle, I combine two data sets, a data set including commodity-level exports at the U.S. port level and a data set with state-level agricultural production, to create a unique weighted-average measure of internal distance.

The impact of internal distance on trade is difficult to estimate because it is plausible that internal distance is endogenous to trade levels. *Ceteris paribus*, firms which export heavily will tend to locate production closer to the port of export as a means of reducing internal trade costs, biasing the estimate of the impact of internal distance. To alleviate this concern, I limit my sample to agricultural goods, which are constrained in production location by climate and soil factors. This allows me to use an instrumental variable strategy, where I instrument actual agricultural production with the Food and Agricultural Organization's (FAO) Global Agro-Ecological Zone project's suitability index. This index essentially ranks the ability of each state to grow a given agricultural good. The measure is created by the FAO using historical measures of climate and soil that are independent of U.S. trade patterns.

I find that the internal distance elasticity of trade is statistically significant and large in magnitude, having a larger impact on trade flows than external distance. I find that, using conservative estimates, a 10% decrease in the distance a good must travel before leaving the United States would increase the exports of that good by 16%. These findings have potentially significant policy implications, particularly with policy makers' decisions to fund internal infrastructure.

This paper proceeds as follows. Section two of this paper gives a brief review of the relevant literature. Section three outlines the empirical specifications and section four details the data used in this paper. Section five details the results. Section six concludes.

Literature Review

This paper contributes to a key literature in international trade which focuses on gravity models of trade and trade costs. Trade economists have long attempted to explain what exactly the trade cost component in the gravity model should properly consist of. Authors have examined the border effect, or the notion that regions are more likely to trade with other regions within their country as compared to international regions. Examples of these papers include McCallum (1995), which found the border effect between Canada and the U.S., Anderson and van Wincoop (2003), which outlined the theoretical justification and an empirical methodology for properly estimating the border effect, and Query (2014) which shows that the border effect is smaller for importers with greater GDP. Many papers have examined the potential trade-encouraging effects of currency and trade unions. Glick and Rose (2002) finds that joining a currency union nearly doubles trade between the sharing countries. Head et al. (2010) finds that strong colonial ties can boost trade. Blonigen and Wilson (2008) and Clark et al. (2004) show that the efficiency of a country's ports significantly impact trade. Most gravity-based papers examine between-country trade costs. In this paper, I further attempt to understand how trade costs drive trade flows, but I am examining the costs a trading firm incurs before a good leaves the country.

Two papers that are directly related to this paper are Agnosteva et al. (2014) and Cosar and Fajgelbam (2014). A recent paper, Agnosteva et al. (2014) outlines a methodology for measuring intra-national border barriers and intra-regional trade costs. The paper finds that intra-regional trade costs are an important consideration in conducting comparative statics. The paper notes the importance of future research "exploring the connection between intra-regional and inter-regional trade costs." Cosar and Fajgelbaum (2014) develops a model which demonstrates that costly trade leads production to move to areas with easy access to foreign ports. Reduction in trade costs results in migration to coastal areas. This finding is supported with data showing that U.S. export-oriented industries are more likely to be located near international ports. This finding is important to the endogeneity discussion in this paper.

Many previous papers examined internal distance, but these papers typically refer to how far a good bought and sold in the same country travels; they do not consider the effect on related international trade flows. For a discussion of how various papers measure this type of internal distance, see Head and Mayer (2002). A few papers do examine internal distance in a similar fashion to this paper. Blonigen and Wilson (2006) estimates a gravity model which includes inland transport prices, as well as inland transport distances, though the latter is included in a market potential variable so no direct internal distance elasticity is estimated. Malchow and Kanafani (2004) uses the distance a good would have to travel before leaving a port to estimate the internal distances effect on port choice, though the paper does not look at trade level effects. While containing no direct measure of distance, Volpe Martincus and Blyde (2013) finds that firms in Chile which experienced a shock to their transportation network saw a decrease in the total value of exports. However, because this paper does not contain a measure of internal distance it does not estimate an internal distance elasticity. Cosar and Demir (2014) uses internal distance measures to calculate the remoteness of Turkish provinces. The authors demonstrate that improved road infrastructure results in increased trade levels. Atkin and Donaldson (2014) uses price gaps to show that intranational trade costs are significantly larger in Ethiopia and Nigeria than in the United States. For a review of literature related to transportation infrastructure, see Redding and Turner (2014).

Empirical Methodology

Gravity Model

The model used to econometrically estimate the elasticities associated with internal and external distance is the gravity model of trade pioneered by Tinbergen (1962) and given theoretical justification by Anderson (1979). The typical log-linearized specification for trade is given by:

$$\ln X_{ijk} = \beta_1 + \beta_2 \ln Y_i + \beta_3 \ln Y_j + \beta_4 Z_{ijk} + \alpha_i + \alpha_j + \alpha_k + \epsilon_{ijk} \quad (3.1)$$

where X_{ijk} is the trade in product k exported by country i to country j, Y_i is the GDP of country i, Z_{ijk} is a vector of explanatory variables, α_i, α_j, and α_k are importer, exporter, and product fixed effects, and ϵ_{ijk} is an i.i.d. error term with mean zero and variance one. As outlined in in Anderson and van Wincoop (2003), this specification should include multilateral resistance terms for both the importer and exporter, which Feenstra (2002) shows can be accounted for using importer and exporter fixed effects. Theoretically, β_2 and β_3 should be equal to one.[1] As such, the gravity equation can be rewritten as:

$$\ln \frac{X_{ijk}}{Y_i Y_j} = \beta_1 + \beta_4 Z_{ijk} + \alpha_i + \alpha_j + \alpha_k + \epsilon_{ijk} \tag{3.2}$$

Variables often included in Z_{ijk} are the distance between i and j, whether i and j share a common language, whether i and j border each other, and whether i and j share a common colonial tie. For this paper, I include the distance between country i and j as well as adding a new variable, the distance good k travels within country i before being exported to country j.

There are a few complications that lead to modifications of equation 3.2 for my data set. First, because the only exporter in my data set is the United States, Y_i and α_i cannot be seperarely identified from the regression's constant.[2] In addition, because the external distance between the United States and a given country is fixed, I cannot include both a measure of external distance and the importer fixed effect α_j. To allow for a comparison of the magnitude between internal and external distance elasticities, I will exclude α_j from my specifications. This could lead to a potential bias in my specification, as the importer multilateral resistance term is not fully accounted for and is potentially correlated with included variables. In addition, I allow the importer income elasticity of trade to differ from one.

[1] However, as noted in my result section, when I allow the income elasticity to differ from one, I find an income elasticity significantly lower than one.

[2] The main importance of the exporter fixed effect is to account for country specific effects including that country's multilateral resistance term, but because there is only one exporter, this fixed effect simply gets subsumed into the constant without generating any bias.

One potential issue with omitting importer fixed effects is that importer-specific factors that impact trade which are typically subsumed into the importer fixed effect are not accounted for.[3] These omitted variables are unlikely to be correlated with internal distance but may bias coefficient estimates, especially with regards to external distance. As a result, the regressions I estimate in this paper will be a variation of the following equation:

$$\ln X_{jk} = \beta_1 + \beta_2 \ln Y_j + \beta_3 \ln EXTDIST_j + \beta_4 \ln INTDIST_{jk} + \beta_5 COMLANG_j \\ + \beta_6 AREA_j + \beta 7 COMCURRj + \beta_8 RTA_j + \beta_9 CONTIG_j + \alpha_k + \epsilon_{jk} \tag{3.3}$$

where X_{jk} is the value of commodity k exported from the United States to country j, Y_j is the GDP of country j, $EXTDIST_j$ is the external distance between the United States and country j, $INTDIST_{jk}$ is the internal distance of commodity k before being exported to country j, $COMLANG_j$ is a dummy variable indicating if the United States and country j share an official language, $AREA_j$ is the geographic area of country j, $COMCURRj$ is a dummy variable taking the value of one if the United States and country j share a common currency, RTA_j is a dummy variable indicating if the United States and country j are in a regional trade agreement, $CONTIG_j$ is a dummy variable taking the value of one if the United States and country j have a contiguous border, and α_k is a commodity fixed effect.

Accounting for Production Location Endogeneity

Within-country distance is likely endogenous. It is possible that producers, at least to some extent, locate their production as close to their customers as is feasible. Thus, producers of exported commodities likely move closer to the coasts, limiting the within-country distance traveled (see, for example, Cosar and Fajgelbaum 2014). To accommodate for this potential endogeneity, I limit my data to agricultural goods. Because of the nature of agricultural goods,

[3] Any U.S.-specific trade determinants will be in the constant term β_1 as the U.S. is the only exporter.

production is limited to a specific area where the climate and soil are suited for growing a crop. As such, agricultural goods are less likely to be subject to this endogeneity concern.

Measuring the distance a good travels within the exporting country before leaving a port is difficult. One potential problem is that a given good-importer pair will almost certainly not originate from the same location. Countries that import corn may get corn from both Indiana and Iowa, for example. In addition, many goods travel through multiple ports for the same importer. Of the 1,175 country-commodity pairs available in my port trade data set, a mere 421 go through only one port. The mean number of ports a country-commodity pair goes through is 3.7, and the most ports a commodity-pair goes through is 48, which is corn to Canada. As a non-Canadian example, Japan's imports of soybeans went through 28 different U.S. ports in 2007.

In this paper, I generate a measure of the internal distance of agricultural goods for a given importer. Due to data limitations, this measure is limited to exports from the United States. I use state shares of agricultural production, as well as port shares in agricultural exports to a given importer, to generate a weighted average of all distances a good can travel before leaving the United States for its final destination. The measure of internal distance for a given commodity and importer pair, $INTDIST_{jk}$, is given by:

$$INTDIST_{jk} = \sum_{s} \sum_{p} \frac{X_{jkp}}{\sum_{p'} X_{jkp'}} \frac{P_{ks}}{\sum_{s'} P_{ks'}} d_{sp} \tag{3.4}$$

where j is the importer, k is the commodity, s is a given state, p is a given port, X_{jkp} is country j's imports of commodity k through port p, P_{ks} is the total production of commodity k in state s, and d_{sp} is the distance from state s to port p. By constructing a weighted average measure of internal distance, I place a higher importance on ports frequently used for a given importer-commodity pair and place little weight on infrequently used ports. In addition, I place a higher weight on states with larger volumes of production of a given commodity and little weight on states that grow very little.

Table 7 includes summary statistics for $INTDIST_{jk}$ by commodity. Because the United States is one of the largest countries in the world, by area, it is not surprising to see such large internal distances for the U.S. Only one good (Tobacco) travels less than 1000 miles, on average, to a port before being shipped to a country. Tomatoes and Potatoes tend to travel the furthest within the United States before being exported.

This measure is still subject to endogeneity concerns. Specifically, it could be the case that crop production locations are determined by the trade demand for these goods. Producers potentially choose to grow crops as close as possible to the ports their crops will ship through, even if that location is not the most ideal location for production. To correct for this possible endogeneity, I create an instrument for $INTDIST_{jk}$, IV_{jk}, which uses the FAO Global Agro-Ecological Zone project's crop suitability index to instrument for actual state agricultural production. The suitability index uses comprehensive soil and climate data to determine how suitable the land of a given U.S. state is for growing a given crop. Further details on construction of this index are in the data section of this paper. The crop suitability index is based only a state's climate and soil conditions and thus is independent of the trade process. Thus, I construct IV_{jk} as follows:

$$IV_{jk} = \sum_{s} \sum_{p} \frac{X_{jkp}}{\sum_{p'} X_{jkp'}} \frac{PP_{ks}}{\sum_{s'} PP_{ks'}} d_{sp} \tag{3.5}$$

where all variables previously described are the same and PP_{ks} is the crop suitability from the Global Agro-Ecological Zone project. This measure is used to instrument for $INTDIST_{jk}$ in a two-stage least squares process.

Data

The data used in this paper come from a variety of sources. The trade data come from the UN Comtrade database. Comtrade provides trade data for a variety of years and levels of aggregation. In this paper, I use 4-digit harmonized system 2007 data for the year 2007 and 4-

digit harmonized system 1992 data for years 1992, 1997, 2002, and 2007.[4] The Comtrade data does not report which port a good went through, information that is necessary in constructing my internal distance measure. To handle this, I use the U.S. port to foreign country trade data for the year 2007 available from the U.S. Census Bureau's USA Trade Online, which is provided at the 4-digit harmonized system level.

Agricultural data comes from two main sources. Actual agricultural production for the U.S. comes from the 2007 Agricultural Census. The Agricultural Census has total production by state for the agricultural products listed in Table 8. A measure of how good a state is at producing a crop, the crop suitability index, comes from the Food and Agricultural Organization Global Agro-Ecological Zone (GAEZ). The crop suitability index is a value between zero and one hundred and is derived from the GAEZ model which estimates the potential crop yield of each state's land using average climate data from 1961 to 1990 as well as data on soil resources and terrain-slope conditions. The index is estimated separately for differing input levels as well as source of water. In this paper, I use the intermediate input level, rain fed suitability index. The FAO GAEZ data have previously been used by Costinot and Donaldson (2011), using both actual and potential production of agricultural goods to measure gains from economic integration. In addition, it was used in Nunn and Qian (2011) to estimate the potential productivity of potatoes in Europe, allowing them to estimate the impact of potatoes on population growth.

State-to-port distances are calculated "as the crow flies," using data on longtitude and latitude coordinates for each state and port. The location data for each state comes from Google Maps,[5] and is measured at the center of the city with the largest population according to the 2000 U.S. Census. Port location data comes from the U.S. Army Corps of Engineers' Navigation Data Center[6]. Gravity variables come from the CEPII Gravity dataset (see Head et al. 2010).

[4] For most specifications, I use the HS2007 data as it is the most detailed data available in 2007. Unfortunately, HS2007 data does not exist prior to 2007, so for the year-by-year comparison I use HS1992 even for the 2007 estimation.

[5] Found using http://www.mapcoordinates.net/en.

[6] The data can be found at http://www.navigationdatacenter.us/ports/ports.asp.

Results

Internal Distance Elasticity

To generate estimates of the various distance elasticities, I estimate variations of equation 3.3 using basic OLS and the IV strategy outlined above. Table 9 reports these estimations using the HS2007 data for the year 2007. Column one is equation 3.3 estimated using the variable $INTDIST_{jk}$ without any instrumental or control variables, while column two excludes control variables but uses 2SLS to instrument for $INTDIST_{jk}$ with IV_{jk}. Column three adds the importer-specific control variables using OLS. Column four uses both importer-specific controls and the IV strategy.

Both columns one and two have an external distance elasticity near unity in magnitude. The distance elasticity of trade being close to one makes intuitive sense, but this result is not often found in empirical estimations. Columns three and four have an external distance elasticity between -0.445 and -0.465, smaller in magnitude than the results in column one and two. This indicates that while transportation costs have a significant impact on trade, costs other than transportation costs such as ease of communication (proxied for by the common language dummy) also have a significant impact on trade and are highly correlated with between-country distance. As expected, the contiguity dummy is large in magnitude, though it is only statistically significant in the IV regression. The regional trade agreement dummy is statistically significant and large in magnitude in both regressions. The other control variables are not statistically significant in either specification.

In all specifications, the coefficient on the log of internal distance is negative, ranging from -1.669 to -2.002, and of a larger magnitude than external distance, which ranges from -0.445 to -1.068. The last row of Table 9 reports the p-value of the test that the coefficient on internal distance is equal to the coefficient on external distance. In my most-preferred specification which is reported in column four, I can reject that the internal distance elasticity is equal to the external distance elasticity at the 5% significance level. A 10% decrease in internal distance would cause a 16-20% increase in trade. This effect is similar to, and potentially larger than, the positive impact on trade than a 10% decrease in the distance between countries, which would only increase trade by 4%-11%.

Because $EXTDIST_j$ is simply a measure of distance between two points while $INTDIST_{jk}$ is a weighted average measure of distances, I report the standardized coefficients for the regressions in Table 10. Using column four as an example, these results say that a one standard deviation decrease in internal distance will increase trade in a given product by 0.23 standard deviations; a one standard deviation decrease in external distance will only increase trade by 0.08 standard deviations. The results here are similar to those of Table 9. The standardized coefficients on internal distance are always larger in magnitude than the standardized coefficients on external distance.

This result has potentially important policy implications. Artificial trade barriers, such as tariffs and quotas, are becoming less relevant given that policies such as free trade agreements push these barriers toward zero. As such, if policy makers look to reducing non-artificial barriers as a means to promote trade, these results indicate that internal trade costs are a potentially fruitful avenue for policy makers to pursue. Not only will improving domestic trade infrastructure be an effective tool in trade promotion, it also creates important externalities for the country. A more efficient transportation network in the United States will not only have a strong impact on the U.S.'s international trade but will also encourage more domestic trade. In addition, domestic investment is more politically palatable than "international" investment.

Finally, Table 9 shows an income elasticity of trade that is different from the one dictated by theory. In fact, the income elasticity of trade is around 0.55 in Table 9. This pattern also holds true in Table 11. While the income elasticity of trade varies year-by-year, going as low as 0.44 in 1992, it hovers around the 0.55 mark for most years and is never close to one.

I now use the potential production index to generate IV estimates. The first-stage F-stat for the instrumental variable is reported in columns 2 and 4. The F-stat is greater than 400, a strong indication that my instrument is correlated with internal distance. The difference between columns one and two and the difference between columns three and four are both negligible. The IV-estimated coefficient is always within one standard deviation of the OLS estimation. The similarity between the OLS and IV estimates is evidence that farmers are not locating their farms based on distance to the port of export. Instead, they are potentially choosing production location based on some other factors, such as soil and climate quality or distance to domestic customers.

Internal Distance Over Time

One natural question that comes from this result is: does this result hold for years besides 2007? To test this, I estimate equation 3.3 using HS1992 data for the years 1992, 1997, 2002, and 2007.[7] These results can be found in Table 11. For the years 1992 and 2007, the trade elasticity of internal distance is about 1.5-1.6%, similar to those found in Table 9. In magnitude, the internal distance elasticity is statistically significant and greater than the external distance elasticity for all years, though the degrees to which they are different vary greatly. For 1992, the coefficients on the two distance measures are different at almost the 90% confidence level while for the years 1997, 2002, and 2007 the coefficients on internal and external distance do not appear to be significantly different. This indicates that international trade is indeed as responsive, if not more responsive, to internal distance than external distance.

Table 11 has another interesting result to note. The external distance elasticity was significantly smaller in 1992 than it is in 2007. In fact, external distance in 1992 has less than half the impact it does in 2007. In addition, the impact of external distance is monotonically increasing in time. A plausible explanation for this result could be the tendency of the United States to move towards exporting those agricultural goods which cost more to ship via boat. This

[7]Note that this means the 2007 results in Table 9, which uses HS2007 instead of HS1992 data, and Table 11 will differ.

result is consistent with the finding in Head and Mayer (2000) which shows that external distance effects have either increased, or remained constant, throughout time.

Conclusion

In this paper, I estimate the elasticity of trade associated with transportation costs that occur within the exporting county. I accomplish this by generating a measure of the distance various goods must travel to a port before being exported. I find that trade barriers occuring within the exporting country have a significant impact on trade flows; the impact of these barriers are potentially more important than external trade barriers.

In order to properly estimate the internal distance elasticity of trade, I combine multiple data sets to arrive at a weighted average measure of the distance a good must travel before leaving the United States. I use state production values and port export data to get an estimate of internal distance. I then include this estimate in a gravity model of trade as a proxy for intranational trade costs.

The location of production for a good may be endogenous to trade levels. I accommodate this potential endogeneity in two key ways. First, I limit my sample to only include agricultural products. Because agricultural products need the correct soil and climate conditions to grow, producers have less options when it comes to production location. To further alleviate this, I use the potential of state land to grow a good as an instrument for actual state production.

I find that internal distance is statistically significant and large in magnitude. In my most conservative estimate, a 10% reduction in internal distance would result in a 16.49% increase in international trade. The IV regression coefficients are similar in magnitude to their OLS counterparts. As such, there is no evidence that agricultural producers are selecting their farm locations based on their international trading partners.

CHAPTER IV

TRADE CREATION AND TRADE DIVERSION IN THE EUROPEAN UNION: DO LARGER COUNTRIES BENEFIT MORE?

Introduction

Regional trade agreements, including free trade agreements and customs unions, have increasingly been used to encourage trade between member countries. Perhaps no regional trade agreement has shaped international trade patterns more than the European Union (E.U.). The E.U. is the largest economy in the world. In addition it goes further than most regional trade agreements, having a currency union and allowing for the free movement of labor between many member nations.

Since the formation of regional trade agreements (RTAs) people have been studying their effects. Viner (1950) first introduced two major outcomes of joining an RTA: the concepts of trade creation and trade diversion. Trade creation is the idea that after joining an RTA, two member countries will trade more with each other. Trade diversion is the idea that member countries will trade less with non-member countries. Typically, trade is being diverted from more efficient non-member countries to less efficient member countries because lower trade barriers between member countries results in a cheaper price despite inefficiencies in production.

In this paper, I contribute to the trade creation and trade diversion literature by demonstrating that the costs and benefits of joining the E.U. are heterogeneous across member nations and, as such, previous estimations of the average effect fail to tell the complete story. I estimate the trade creation and trade diversion effects for each country that joined the European Union between the years 1962 and 2010 and show that these effects differ from country to country. Furthermore, I demonstrate a variety of causes for this heterogeneity in trade creation and trade diversion effects. I provide strong evidence that the economic size of a member nation is a key component of trade creation and trade diversion heterogeneity. Economically larger E.U. members face smaller trade creation and trade diversion effects; they continue to trade extensively with non-E.U. members. On the other hand, smaller countries become more dependent on other E.U. members, importing less from and exporting less to non-E.U. members. Certain country groups also see heterogeneous effects. On average, countries see a 26% jump in trade with other E.U. members upon joining the E.U. Similarly, they see a 13.8% decrease in trade with non-E.U. members. Scandinavian countries, however, see smaller trade creation and trade diversion effects than the E.U. average. Interestingly, former Eastern Bloc countries see an increase in trade with E.U. members of 150%, resulting in a trade creation effect that is significantly higher than the E.U. average. In addition, rather than seeing a decrease in trade with non-E.U. members, Eastern Bloc countries actually increase their trade with non-E.U. members.

This paper proceeds as follows. In the next section, I briefly review the related trade creation and trade diversion literature. In section three I outline the model to be estimated. Section four describes the data used in this paper and section five describes the results. Section six concludes.

Literature Review

This paper contributes to three key literatures: the regional trade agreement literature, the related trade creation and trade diversion literature, and the border effect of trade literature. This paper addresses various aspects of all three literatures while also adding to each.

A sizable literature exists which uses the gravity model of trade to estimate the impact of regional trade agreements on bilateral trade levels. Head et al. (2010) includes a regional trade agreement dummy in the gravity equation and finds that trade is greater for two RTA members than for similar nonmembers. Several papers have included a dummy variable for currency unions in the gravity model, including Rose (2000) and Nitsch (2002). Both find that a currency union increases trade, though Nitsch's effect is half that of Rose's. Haveman and Hummels (1998) find that RTAs can divert trade away from member countries and they can increase trade for non-member countries.

A related literature examines the endogenous process of joining an RTA. Baier and Bergstrand (2004) find that key determinants of joining an RTA include distance between countries, remoteness of partners from the rest of the world, the economic size of the trading partners, and the proximity of the trading partners. However, to my knowledge, no paper dealing with the trade creation or diversion associated with an RTA has examined heterogeneous benefits of RTAs as I do in this paper. In addition, Baier and Bergstrand (2007) show that the most appropriate method for handling this endogeneity is doing a panel approach with bilateral and time fixed effects; I follow their methodology in this paper.

A significant literature exists examining the trade creation and trade diversion effects of regional trade agreements. Viner (1950) first introduced the concepts of trade creation and trade diversion. These concepts have been expanded on heavily in the last half century. Panagariya (2000) is a detailed survey of the theoretical literature dealing with trade creation and trade diversion. A recent paper estimating these two effects is Magee (2008), which uses fixed effects in a gravity model to control for the "natural trading partner" hypothesis introduced by Wonnacott and Lutz (1989) and Krugman (1991). This hypothesis states that partners which previously had large trade levels are more likely to enter into a regional trade agreement. I deal with this "natural trading partner" problem by only examining the overall increase in trade during the period following joining an RTA. Magee (2008) finds that regional trade agreements have a significant impact on trade both before joining the RTA ("anticipatory effects") and for several years after joining. This implies that my estimation results are lower bounds of the trade creation and trade diversion effects.

Lastly, this paper is related to the literature concerning the border effect, or home bias, of trade. The idea that, controlling for relevant variables, two regions within a country are significantly more likely to trade with each other than with international regions was introduced by McCallum (1995) and expanded on by Anderson and van Wincoop (2003) among others.[1] One border effect paper of particular relevance is Nitsch (2000). Nitsch finds that the border effect exists among E.U. members; despite the E.U.'s goal of economic integration, E.U. members are ten times more likely to trade with themselves than with other E.U. members. Nitsch also finds that countries with a larger per-capita GDP have smaller border effects. Chen (2004) also finds border effects among E.U. members and demonstrates that technical barriers to trade and information costs can explain these border effects. Of note is that both of these papers examine the country-level border effect rather than a "European Union Border effect." I treat the E.U. as one country to estimate the border effect and then further estimate how economic size may impact the magnitude of the border effect using an idea similar to Query (2014).

Model

This paper uses the gravity model of trade, outlined in Tinbergen (1962), to estimate the impact of joining the European Union on international trade levels. In addition, I follow the methodology of Baier and Bergstrand (2007) and include importer-exporter and time fixed effects. The typical gravity model can then be written as:

$$\ln X_{ijt} = \beta_1 + \beta_2 \ln GDP_{it} + \beta_3 \ln GDP_{jt} + \beta_4 \ln GDPPC_{it} + \beta_5 \ln GDPPC_{jt} + \beta_6 Z_{ijt} + \alpha_{ij} + \alpha_t + \epsilon_{ijt} \tag{4.1}$$

where X_{ijt} is the trade from exporter i to importer j in year t, GDP_i is the gross domestic product of country i, $GDPPC_i$ is the GDP-per-capita of country i, Z_{ijt} is a vector of ijt specific variables, α_{ij} are importer-exporter fixed effects, and α_t is a time fixed effect.

[1] A non-exhaustive list includes Wolf (2000), Feenstra (2002), Hillberry and Hummels (2003), and Wolf (2005).

Trade Creation and Trade Diversion

To estimate the trade creation and trade diversion effects of joining the E.U., I modify equation 4.1 to include a set of variables related to a country's relative status to the E.U. This results in the following equation:

$$\ln X_{ijt} = \beta_1 + \beta_2 \ln GDP_{it} + \beta_3 \ln GDP_{jt} + \beta_4 \ln GDPPC_{jt} + \beta_5 \ln GDPPC_{jt} + \beta_6 EUEU_{ijt} + \beta_7 EUNONEU_{ijt} + \beta_8 EUROEURO_{ijt} + \alpha_{ij} + \alpha_t + \epsilon_{ijt} \tag{4.2}$$

where $EUEU_{ijt}$ is a dummy variable equal to one if both i and j are members of the E.U. in year t $EUNONEU$ is equal to one if one country is a member of the E.U. in year t and the other is not, and $EUROEURO_{ijt}$ is equal to one of both countries are members of the Eurozone in year t. The coefficient β_6 represents the average percentage trade created between two members by joining the E.U. and β_7 is the average percentage trade decrease, or diversion, from non-E.U. members which is caused by joining the E.U. As such, theory dictates that β_6 should be positive and β_7 should be negative.

Heterogeneity in Trade Creation and Trade Diversion

Equation 4.2 estimates the average trade creation and trade diversion effects of the E.U. However, there is no reason to suspect that the European Union impacts each member in the same way. For example, Query (2014) indicates that trade barriers can impact economically-smaller regions differently than their economically-larger counterparts. The paper argues that fixed costs of crossing the border result in smaller per-unit costs in larger importing regions. In addition, the paper argues that easy of marketing to larger regions may be a factor. In this paper, I demonstrate heterogeneity in the trade creation and trade diversion effects and then examine multiple causes of this heterogeneity. I expect to see larger E.U. members to see smaller trade diversion effects. Large E.U. members are likely to be competitive enough to overcome the extra trade barrier created when joining the E.U. On the other hand, smaller E.U. members may struggle to overcome the E.U. border effect and, as such, will become reliant on large E.U. members as their main trading partners.

To demonstrate heterogeneity in the trade creation and diversion effects of the European Union, I estimate the trade creation and trade diversion effects for each country that joined the E.U. during my sample. Thus, I estimate equation 4.2 for each member country, requiring either i or j to be the country of interest.

Having demonstrated heterogeneity in trade creation and diversion caused by the E.U., I explore multiple potential causes of this heterogeneity. Following Query (2014), I explore the idea that the trade creation and diversion effects of the E.U. may be a function of economic size. Thus, I estimate the following equation:

$$\begin{aligned} \ln X_{ijt} = \beta_1 + \beta_2 \ln GDP_{it} + \beta_3 \ln GDP_{jt} + \beta_4 \ln GDPPC_{jt} + \beta_5 \ln GDPPC_{jt} + \\ \beta_6 EUEU_{ijt} + \beta_7 EUNONEU_{ijt} + \beta_8 EUROEURO_{ijt} + \beta_9 EUEU_{ijt} \times GDP_i \\ + \beta_{10} EUNONEU_{ijt} \times GDP_i + \beta_{11} EUEU_{ijt} \times GDP_j + \beta_{12} EUNONEU_{ijt} \times GDP_j + \\ \alpha_{ij} + \alpha_t + \epsilon_{ijt} \end{aligned} \tag{4.3}$$

Query (2014) suggests that β_{10} and β_{12} would be negative if E.U. member countries face the "border effect" in the same way as U.S. states and Canadian provinces, though this need not be true. Query (2014) offers no suggestion on the the sign of either β_9 or β_{11}.

In addition, I explore the possibility that natural country groups may experience trade creation and trade diversion differently. I first explore the idea that Eastern Bloc countries experience trade creation and trade diversion in a manner different than that of the rest of the E.U. Strong influence from the Soviet Union meant this countries emerged from communism to embrace capitalist markets during my sample. As such, they are likely to experience economic shocks differently than other E.U. members. Next, I examine whether Scandinavian and non-

Scandinavian states see differing effects of joining the E.U. I suspect these countries may be different than other E.U. members because of the seeming opposition to the E.U. in Scandinavia. Norway has not joined the E.U. and neither Sweden or Denmark have joined the Eurozone. The equation used for these estimations is equation 4.2 but requiring that either i or j be a member of the relevant group of countries.

Data

The trade data used in this paper comes from the UN Comtrade database. Comtrade contains imports and exports between partners for many years and varying degrees of disaggregation. For this paper, I use the Comtrade data at the SITC Rev.1 level. I then aggregate this data to arrive at total importer-exporter trade. This allows me to create a panel from 1962 to 2010. Trade values are adjusted to constant-value using the Consumer Price Index with 1982-1984 as the base year. The CPI comes from FRED.

Unfortunately, this dataset reports Belgium and Luxembourg as one country from 1962 to 1998 and as separate countries from 1999 on. I leave Luxembourg and Belgium as separate observations from 1999 on to allow for the possibility that smaller countries like Luxembourg face larger border effects. In addition, I drop East Germany from my specification and treat pre-1991 West Germany as the same country as post-1991 Germany.[2]

Dates for when each country joined the European Union and the Eurozone were retrieved from the European Union's official website. Purchasing-power parity adjusted gross domestic product and country population come from the Penn World Table and cover the entire panel from 1962 to 2010.

My observations are at the importer-exporter-year level. The countries that join the E.U. during my sample, and thus are the source of variation in my specifications, are Austria, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Latvia,

[2]This details are mentioned for clarity but do not have a significant impact on the empirics present in this paper.

Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. For each of these countries, I have created regression discontinuity graphs on total trade before and after joining the European Union. That is, I regressed the following equation on two different time periods for each country that joins the E.U. in my sample, all years before a country joined the European Union and all years after:

$$X_{it} = \alpha + \beta t + \epsilon_{it} \tag{4.4}$$

These graphs can be found in Figures 4 through 14.

Results

This section reports the results of the regressions mentioned in the Empirical Model section. I begin by estimating the trade creation and trade diversion effects of being a European Union member. I then individually estimate the trade creation and trade diversion effect individually for each member state to demonstrate heterogeneous effects. Finally, I investigate potential causes for this heterogeneity.

Trade Creation and Trade Diversion

Column 1 of Table 12 reports the estimation of equation 4.2. The results are as expected. A positive coefficient on the E.U. to E.U. trade dummy indicates E.U. member states trade more with each other than two comparable non-E.U. member countries. This is the trade creation effect of the E.U. Similarly, a negative coefficient on the E.U./non-E.U. trade dummy means that E.U. member states tend to trade less with non-E.U. members than two comparable non-E.U. members. This is the trade diversion effect.

The trade creation coefficient is positive and statistically significant at the 99% confidence level and the magnitude is economically significant. E.U. to E.U. trade is 26% larger than non-

E.U. to non-E.U. trade.[3] It is worth noting that this effect is significantly smaller than the border effect between the U.S. and Canada, which is closer to 300%.[4] However, the border effect within the E.U. may still be as large as that seen in the U.S.-Canada border effect literature. The trade diversion coefficient is negative and statistically significant at the 99% confidence level. E.U. member states trade 13.8% less with non-E.U. members than you would see from two comparable non-E.U. members.[5] This effect is economically significant but smaller than the trade creation effect.

Another result worth noting from column 1 of Table 12 is that the coefficient on the Euro to Euro trade dummy is not statistically significant. This is evidence that, after controlling for time and importer-exporter fixed effect, being in the Eurozone does not have trade creation effects above and beyond that which a member state could expect from being in the European Union.

Individual Trade Creation and Trade Diversion Effects

Column 1 of Table 12 reports the average trade creation and trade diversion effects, but there is no reason to assume the impact the E.U. has on member nations is uniform. In Table 13 I report the individually estimated trade creation and trade diversion effects as well as their standard errors. Column 1 of Table 13 reports the coefficient on E.U. to E.U. trade for each individual country and column 2 reports the standard error for that estimate. Column 3 reports the individually estimated E.U. to non-E.U. coefficient and column 4 reports that coefficient's standard error.

Table 13 shows considerable heterogeneity in the effects of joining the European Union. Interestingly, only Hungary and Romania have coefficients with the same sign as the average. Every other country has either a positive coefficient on both variables of interest or a negative

[3] $e^{0.234} - 1$

[4] See Anderson and van Wincoop (2003) and Feenstra (2002) for estimates of U.S-Canada border effect size.

[5] $e^{-.149} - 1$

coefficient on both variables. That is, while on average there is a positive cofficient for E.U. to E.U. trade and a negative coefficient for E.U. to non-E.U. trade, for most individual E.U. members either trade with both E.U. countries and non-E.U. countries rose or trade with both E.U. and non-E.U. countries fell. Countries which saw trade with both E.U. and non-E.U. countries rise include Bulgaria, Denmark, Estonia, Latvia, Malta, Poland, Slovakia and Slovenia. Cyprus, Ireland, and the United Kingdom have positive coefficients on both the E.U. to E.U. and E.U. to non-E.U. coefficients; however, the E.U. to non-E.U. coefficient is not statistically significant. Neither coefficient is statistically significant for the Czech Republic and Finland.

Several countries see trade decrease both with E.U. countries and non-E.U. countries on average. For Greece, Lithuania, and Spain, both coefficients are negative and statistically significant. This implies that for these countries joining the European Union unequivocally decreased trade. Austria, Portugal, and Sweden have negative and statistically significant coefficients on E.U. to non-E.U. trade; their E.U. to E.U. coefficient is negative but not statistically significant. They appear to see trade diversion from non-E.U. members while failing to see the trade creation effect of the E.U.

A few interesting patterns emerge from this analysis. Both countries that saw the same coefficients as the average members are from the Eastern Bloc. In addition, it is worth noting that five of the nine Eastern Bloc countries are included in this group. In fact, the only Eastern Bloc country that has a negative and statistically significant coefficient on E.U. to E.U. trade is Lithuania. The European Union seems to have been a significant boost to trade for the Eastern Bloc. In addition, the two Scandinavian countries that are E.U. members are Denmark and Sweden. Denmark saw trade rise with both E.U. and non-E.U. members after joining the E.U. Sweden, however, saw the negative trade diversion effect with no corresponding trade creation effect. Despite both being Scandinavian countries, they see vastly differing effects of the European Union. I explore heterogeneity among nation groups later in this paper.

Market Size

Given the established heterogeneity in the effect of joining the E.U., I now turn to various explanations of this heterogeneity. I first examine the "market size effect" documented in Query (2014). Column 2 of table 12 reports the results for the estimation of equation 4.3. The negative coefficient on the interaction of importer GDP and the E.U. to E.U. trade dummy indicates that larger E.U. members see a smaller increase in imports from other E.U. countries. One explanation for this is that larger countries face a smaller barrier to trade with non-E.U. countries and as such divert less trade from non-E.U. to E.U. members. The negative coefficient on the interaction between exporter GDP and the E.U. to E.U. dummy says that larger E.U. members also divert a smaller fraction of their exports to E.U. members. These two results imply that smaller E.U. members become reliant on larger E.U. members as they both import and export more heavily from E.U. members than their larger counterparts, while the larger E.U. members continue to trade heavily with outside countries.

Another interesting result reported in column 2 of table 12 is the negative coefficient on the interaction of importer GDP and the E.U. to non E.U. dummy. This goes against the results of Query (2014) and says that smaller E.U. members see a smaller decrease in non-E.U. trade than their larger counterparts. A potential explanation for this is that, all else equal, simply joining the European Union makes a country a more attractive trading partner. This could be because of implied financial stability, confidence in the reliability of courts and laws, or the ease of extending trading networks from one E.U. country to another. This result alleviates some of the reliance on larger E.U. countries for imports as mentioned above. Exporter GDP does not appear to have an effect on the diversion of exports from non-E.U. to E.U. countries.

Heterogeneous Effects for Differing Nation Groups

Another potential source of heterogeneity is that joining the E.U. impacts groups of nations differently. Column 3 of Table 12 reports the results for only the Eastern Bloc countries, all of which are members of the European Union.[6] Note that the coefficient on E.U. to E.U. trade is statistically significant at the 99% confidence level and is of a magnitude larger than the average E.U. to E.U. effect. Eastern Bloc countries see an increase in trade with other E.U. members of more than 150%.[7] This is both statstically and economically significantly different than the 26% average effect. Not only is the trade creation effect for Eastern Bloc countries higher, but the coefficient on E.U. to non-E.U. trade is positive and statistically significant. Rather than diverting trade from non-E.U. countries, the Eastern Bloc countries actually increased trade with non-E.U. countries after joining the E.U.

These results suggests that the Eastern Bloc countries unequivocally benefit from joining the E.U. One potential explanation for this result is that, as mentioned previously, E.U. membership itself acts as a signal of consistent and predictable economic and monetary stability. Another potential explanation is that Eastern European countries function as export platforms for the European Union, with significant FDI taking place in these countries due to their E.U. membership and low wages.

Finally it is important to note that while on average the adoption of Euro has no effect on trade, for the Eastern Block countries which adopted the Euro the Euro has a positive, statistically significant, and economically significant impact on trade. The Eastern Bloc countries trade 42% more with other Eurozone members than with non-Eurozone E.U. countries.[8]

Column 4 of Table 12 shows the impact of the European Union on Scandinavian countries.[9] Unlike the Eastern Bloc, which had all members join the E.U., not all Scandinavian countries are E.U. members. Norway is not an E.U. member and does not participate in the customs union, though they do participate in the European Economic Area. No Scandinavian country

[6] These countries are Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Slovakia.

[7] This number is equal to $1 - e^{.938}$.

[8] This number is equal to $1 - e^{.348}$.

[9] These countries are Norway, Denmark, and Sweden.

participates in the Eurozone. The Scandinavian countries see the same signs on all major coefficients though with smaller magnitudes. The Scandinavian countries see a trade creation effect of approximately 20%[10] and a trade diversion effect of only -8%.[11] The trade creation effect is only statistically significant at the 90% confidence level and the trade diversion effect is not statistically significant.

Conclusion

Fully understanding the effects of regional trade agreements is important for examining their usefulness as trade creation policies. International trade economists have been examining the impact of RTAs on trade, most often estimating the average trade creation and trade diversion effects of joining an RTA. Key amongst this research is an examination of the impact of the largest regional trade agreement, the European Union.

In this paper, I show that estimating the average trade creation and trade diversion effects of the European Union is not sufficient for understanding if joining the E.U. is beneficial for a country. I individually estimate the trade creation and trade diversion effects of the E.U. and demonstrate that these effects differ from country to country. I then explore multiple causes of this heterogeneity. Larger E.U. members see less trade creation and less trade diversion, while smaller members become more reliant on other E.U. members for trade. In addition, Scandinavian countries see smaller trade creation and trade diversion effects while Eastern Bloc countries see larger trade creation effects while also increasing trade with non-E.U. members. To understand if joining the E.U. is beneficial for a country, one must consider the whole picture.

[10]This number is equal to $1 - e^{.187}$.

[11]This number is equal to $1 - e^{-.079}$.

CHAPTER V

CONCLUSION

International trade is welfare creating. As such, policy makers constantly seek to increase international trade levels. As free trade agreements bring tariff levels ever close to zero worldwide, the policy instruments available to these policy makers shrink. This dissertation examines non-tariff trade barriers, diving below the surface and seeking to fully understand how these implicit trade costs impact international trade levels. In doing so, this dissertation allows policy makers to make a better-informed decision. I have outlined three major contributions to the understanding of how non-tariff trade costs impact international trade.

The first key contribution of this dissertation is the examination of how the border effect is a function of importer market size. While previous literature, such as Anderson and van Wincoop (2003), has tried to explain away the border effect found in McCallum (1995), I attempt to understand exactly what the border effect is composed of. In Chapter II, I demonstrate that the border effect is heterogeneous across regions in the same country. Further, I demonstrate that a cause of this heterogeneity is importer market size. Ease of marketing access, as well as fixed costs of crossing the border resulting in lower per-unit costs, mean that economically larger regions of a country are better able to trade internationally than their smaller counterparts.

The second key contribution is the examination of internal transportation costs. While transportation costs have long been a focus of the international trade literature, researchers typically have focused on the transportation costs of moving a good from one country to another. This completely ignores an important component of transportation costs: getting a good from the place of production to the port of export. In Chapter III, I demonstrate that internal transportation costs significantly lower international trade levels. In doing so, I employ a unique instrumental variable strategy to handle the endogeneity of production location.

The final contribution is demonstrating that joining the European Union has heterogeneous effects across member nations. In Chapter IV, I revisit the well known fact that the E.U., on average, increases trade with between its members, known as trade creation, while simultaneously lowering trade with non-E.U. members, known as trade diversion. This average effect is what is typically calculated in the international trade literature. I then go one step further and demonstrate that each of these effects differs from member to member. Indeed, the Eastern Bloc countries not only see significantly more trade with E.U. members than the average country, they actually increase trade with non-E.U. members as well. While the literature has often noted that the European Union has had a positive effect on trade, without fully understanding the heterogeneity of the trade creation and trade diversion effects one cannot say if a specific member benefited, or indeed if a specific country should seek to join the E.U.

The chapters of this dissertation offer several avenues of future research. Chapter II demonstrates that the border effect is also a function of exporter size. Larger regions face a smaller border effect when exporting. However, no explanation is offered for this heterogeneity. Future research could explain why exporter market size is important. While Chapter III is innovative in demonstrating that the costs of moving a good from the place of production to the port of export matter, data limitations prevented me from examining an equally important trade cost: the transportation cost of moving a good from the port of entry to its final customer. Understanding these costs would allow for a complete understanding of each link in the transportation of internationally traded goods. By continuing with these avenues of research, society can make better informed trade policy in a world where lowering tariffs is no longer a viable options.

APPENDIX

TABLES AND FIGURES

TABLE 1. States Excluded from Previous Literature

Alaska	Arkansas	Colorado	Connecticut
Delaware	Hawaii	Iowa	Kansas
Mississippi	Nebraska	Nevada	New Mexico
Oklahoma	Oregon	Rhode Island	South Carolina
South Dakota	Utah	West Virginia	Wyoming

TABLE 2. Border Heterogeneity - OLS - Independent Variable $\ln\left(\frac{X_{ij}}{Y_i Y_j}\right)$

	(1) AvW	(2) AvW	(3) AvW	(4) AvW
Log Distance	-1.902***	-1.919***	-1.902***	-1.919***
	(0.034)	(0.035)	(0.034)	(0.035)
Border Dummy	-2.009***	-3.269***	-4.880***	-6.055***
	(0.080)	(0.651)	(0.595)	(0.886)
Distance X Border		0.167*		0.159*
		(0.086)		(0.087)
Importer Market Size X Border			0.269***	0.267***
			(0.054)	(0.054)
Importer Exporter Fixed Effect	Yes	Yes	Yes	Yes
Number of States	48	48	48	48
Observations	3118	3118	3118	3118
R^2	0.997	0.997	0.997	0.997

* p < 0.1, ** p < 0.05, *** p < 0.01. Robust standard errors in parentheses.

TABLE 3. Robustness Check - OLS - Independent Variable $\ln\left(\frac{X_{ij}}{Y_i Y_j}\right)$

	(1) AvW	(2) AvW
Log Distance	-1.919***	-1.923***
	(0.035)	(0.035)
Border Dummy	-6.055***	-6.003***
	(0.886)	(0.898)
Distance X Border	0.159*	0.188**
	(0.087)	(0.088)
Importer Market Size X Border	0.267***	0.198***
	(0.054)	(0.066)
Log Importer Population Density x Border Dummy		0.135**
		(0.061)
Importer Exporter Fixed Effect	Yes	Yes
Number of States	48	48
Observations	3118	3118
R^2	0.997	0.997

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses.

TABLE 4. Robustness Checks - OLS - Independent Variable $\ln\left(\frac{X_{ij}}{Y_i Y_j}\right)$

	(1) AvW	(2) Exporter Size	(3) Importer and Exporter Coast	(4) Coast Interact
Log Distance	-1.919***	-1.918***	-1.201***	-1.201***
	(0.035)	(0.035)	(0.025)	(0.025)
Border Dummy	-6.055***	-7.789***	-1.685**	-1.745**
	(0.886)	(1.015)	(0.854)	(0.855)
Distance X Border	0.159*	0.155*	-0.440***	-0.437***
	(0.087)	(0.088)	(0.077)	(0.077)
Importer Market Size X Border	0.267***	0.274***	0.266***	0.281***
	(0.054)	(0.055)	(0.054)	(0.054)
Exporter Market Size X Border		0.159***		
		(0.045)		
Importer Coastal States			-7.788***	-8.115***
			(0.441)	(0.439)
Exporter Coastal States			-0.864**	-0.512
			(0.383)	(0.384)
Importer Coast X Border Dummy				0.335
				(0.470)
Exporter Coast X Border Dummy				-0.537
				(0.487)
Importer Exporter Fixed Effect	Yes	Yes	Yes	Yes
Number of States	48	48	48	48
Observations	3118	3118	3118	3118
R^2	0.997	0.997	0.998	0.998

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses.

TABLE 5. Poisson Estimations - Independent Variable $\left(\frac{X_{ij}}{Y_i Y_j}\right)$

	(1) PQML	(2) PQML	(3) PQML	(4) PQML	(5) PQML	(6) PQML: (1-Border)
Log Distance	-2.079***	-2.016***	-2.019***	-2.017***	-2.019***	-1.948***
	(0.031)	(0.027)	(0.028)	(0.027)	(0.028)	(0.164)
Border Dummy	-1.089***	-1.089***	-1.479	-1.396*	-1.774	-3.453***
	(0.107)	(0.088)	(0.945)	(0.764)	(1.285)	(1.254)
Distance X Border			0.057		0.057	
			(0.130)		(0.131)	
Importer Market Size X Border				0.029	0.029	
				(0.072)	(0.073)	
(1-Border) X Distance						0.604***
						(0.153)
(1-Border) X Market Size						-0.591***
						(0.026)
Importer Exporter Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Number of States	30	48	48	48	48	48
Observations	1582	3143	3143	3143	3143	3143
R^2						

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses.

TABLE 6. Negative Binomial Estimations - Independent Variable $\left(\frac{X_{ij}}{Y_i Y_j}\right)$

	(1) NB	(2) NB	(3) NB	(4) NB	(5) NB: (1-Border)
Log Distance	-2.079***	-2.016***	-2.019***	-2.019***	-1.912***
	(0.031)	(0.027)	(0.028)	(0.028)	(0.163)
Border Dummy	-1.089***	-1.089***	-1.479	-1.774	-3.689***
	(0.107)	(0.088)	(0.945)	(1.285)	(1.254)
Distance X Border			0.057	0.057	
			(0.130)	(0.131)	
Importer Market Size X Border				0.029	
				(0.073)	
(1-Border) X Distance					0.571***
					(0.152)
(1-Border) X Market Size					-0.593***
					(0.026)
Importer Exporter Fixed Effect	Yes	Yes	Yes	Yes	Yes
Number of States	30	48	48	48	48
Observations	1582	3143	3143	3143	3143
R^2					

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses.

TABLE 7. Summary Statistics for Internal Distance by Product

	mean	max	min	sd	count
Barley	1706	2217	1526	307	7
Grain	1006	2644	606	570	50
Maize	1448	3486	840	452	96
Oats	1797	2567	1094	463	19
Potatoes	2148	3121	1561	564	29
Rice	1592	3536	859	642	99
Soy	1459	2655	932	408	44
Tobacco	898	3526	510	555	41
Tomatoes	2648	3252	821	857	16
Wheat	1628	2162	1107	273	78
Total	1515	3536	510	630	479

All numbers are reported in miles.

TABLE 8. Products Included in Sample

HS Code	Description	Non-IV Sample	IV Sample
0701	Potatoes (except sweet potatoes), fresh or chilled	Yes	Yes
0702	Tomatoes, fresh or chilled	Yes	Yes
0708	Leguminous vegetables, shelled or not, fresh or chilled	Yes	No
0805	Citrus fruit, fresh or dried	Yes	No
0806	Grapes, fresh or dried	Yes	No
0808	Apples, pears, and quinces, fresh	Yes	No
0809	Apricots, cherries, peaches, plums & sloes, fresh	Yes	No
1001	Wheat and meslin	Yes	Yes
1003	Barley	Yes	Yes
1004	Oats	Yes	Yes
1005	Corn (maize)	Yes	Yes
1006	Rice	Yes	Yes
1007	Grain sorghum	Yes	Yes
1201	Soybeans, whether or not broken	Yes	Yes
1202	Peanuts (ground-nuts), raw	Yes	No
1206	Sunflower seeds, whether or not broken	Yes	No
1214	Rutabagas, hay, clover & other forage products	Yes	No
2401	Tobacco, unmanufactured	Yes	Yes

TABLE 9. Internal Distance Gravity Regressions

	(1) Basic Reg, No IV	(2) Basic Reg, 2SLS	(3) Controls Reg, No IV	(4) Controls Reg, 2SLS
Log of External Distance	-1.053**	-1.068***	-0.445	-0.465*
	(0.382)	(0.211)	(0.415)	(0.262)
Log of Internal Distance	-1.936***	-1.669***	-2.002***	-1.754***
	(0.479)	(0.504)	(0.518)	(0.497)
Log of Importer GDP	0.533***	0.538***	0.431***	0.433***
	(0.086)	(0.057)	(0.074)	(0.073)
Contiguity Dummy			1.796	1.772**
			(1.039)	(0.759)
Common Language Dummy			-0.294	-0.318
			(0.274)	(0.272)
Log of Importer Area			0.012	0.014
			(0.087)	(0.064)
Colonial Dummy			0.411	0.408
			(0.564)	(0.475)
RTA Dummy			1.010*	1.002***
			(0.529)	(0.337)
Common Currency Dummy			0.476	0.467
			(0.565)	(0.607)
Fixed Effects Used	Commodity	Commodity	Commodity	Commodity
Observations	479	479	479	479
R^2	0.241	0.240	0.274	0.274
First-stage F-stat		400.859		403.439
P-value of test $\ln intdist \neq \ln dist$	0.272	0.292	0.100	0.031

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses.

TABLE 10. Internal Distance Gravity Regressions: Standardized Coefficients

	(1) Basic Reg, No IV	(2) Basic Reg, 2SLS	(3) Controls Reg, No IV	(4) Controls Reg, 2SLS
Log of External Distance	-0.183**	-0.186***	-0.077	-0.081*
	(0.382)	(0.211)	(0.415)	(0.262)
Log of Internal Distance	-0.257***	-0.222***	-0.266***	-0.233***
	(0.479)	(0.504)	(0.518)	(0.497)
Log of Importer GDP	0.349***	0.352***	0.282***	0.283***
	(0.086)	(0.057)	(0.074)	(0.073)
Contiguity Dummy			0.109	0.108**
			(1.039)	(0.759)
Common Language Dummy			-0.043	-0.046
			(0.274)	(0.272)
Log of Importer Area			0.009	0.010
			(0.087)	(0.064)
Colonial Dummy			0.032	0.031
			(0.564)	(0.475)
RTA Dummy			0.119*	0.118***
			(0.529)	(0.337)
Common Currency Dummy			0.030	0.029
			(0.565)	(0.607)
Fixed Effects Used	Commodity	Commodity	Commodity	Commodity
Observations	479	479	479	479
R^2	0.241	0.240	0.274	0.274
First-stage F-stat		400.859		403.439
P-value of test $\ln intdist \neq \ln dist$	0.272	0.292	0.100	0.031

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses.

TABLE 11. Internal Distance Gravity Regressions - Various Years

	(1) 1992	(2) 1997	(3) 2002	(4) 2007
Log of External Distance	-0.424*	-0.809***	-0.832***	-1.035***
	(0.252)	(0.224)	(0.221)	(0.211)
Log of Internal Distance	-1.609**	-1.006*	-1.061**	-1.554***
	(0.653)	(0.603)	(0.540)	(0.505)
Log of Importer GDP	0.437***	0.579***	0.538***	0.570***
	(0.065)	(0.063)	(0.060)	(0.057)
Fixed Effects Used	Commodity	Commodity	Commodity	Commodity
Type of Intrsument	Yes, 2SLS	Yes, 2SLS	Yes, 2SLS	Yes, 2SLS
Observations	326	369	354	471
R^2	0.144	0.199	0.220	0.248
First-stage F-stat	358.056	368.457	393.704	418.454
P-value of test $\ln intdist \neq \ln dist$	0.101	0.761	0.704	0.360

* p < 0.1, ** p < 0.05, *** p < 0.01. Robust standard errors in parentheses.

TABLE 12. Trade Creation and Trade Diversion in the E.U.

	(1) EU Border Effect	(2) Market Size Effect	(3) EU Border Effect	(4) EU Border Effect
EU to EU trade	0.234***	2.312***	0.938***	0.187*
	(0.042)	(0.402)	(0.064)	(0.107)
EU to Non-EU trade	-0.149***	0.164	0.348***	-0.079
	(0.024)	(0.164)	(0.040)	(0.066)
Euro to Euro trade	-0.074	0.009	0.194**	
	(0.052)	(0.054)	(0.093)	
Importer GDP * EU to EU dummy		-0.074***		
		(0.023)		
Exporter GDP * EU to EU dummy		-0.099***		
		(0.025)		
Importer GDP * EU to non-EU dummy		-0.027**		
		(0.011)		
Exporter GDP * EU to non-EU dummy		-0.001		
		(0.012)		
Sample	all	all	Eastern Bloc	Scandinavia
Observations	532017	532017	45994	34480
Fixed Effects	Importer-Exporter	Importer-Exporter	Importer-Exporter	Importer-Exporter
Time Fixed Effects	Yes	Yes	Yes	Yes
R^2	0.105	0.105	0.106	0.090

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses.

TABLE 13. Individual Trade Creation and Trade Diversion Effects

Country	(1) EU to EU	(2) EU to EU Standard Error	(3) EU to Non-EU	(4) EU to Non-EU Standard Error
Austria	-0.126	0.122	-0.220	0.084
Bulgaria	1.063	0.129	0.569	0.085
Cyprus	0.503	0.152	0.032	0.010
CzechRep	0.110	0.142	0.031	0.086
Denmark	0.742	0.181	0.248	0.089
Estonia	0.355	0.163	0.219	0.106
Finland	-0.130	0.154	-0.038	0.089
Greece	-0.869	0.166	-0.740	0.101
Hungary	0.798	0.154	-0.009	0.091
Ireland	0.475	0.191	0.193	0.120
Latvia	0.636	0.205	0.245	0.114
Lithuania	-0.165	0.204	-0.295	0.129
Malta	0.677	0.172	0.329	0.099
Poland	1.122	0.129	0.375	0.082
Portugal	-0.012	0.186	-0.310	0.089
Romania	0.913	0.170	-0.057	0.110
Slovakia	0.647	0.165	0.315	0.107
Slovenia	0.398	0.180	0.248	0.125
Spain	-0.295	0.150	-0.459	0.072
Sweden	-0.125	0.131	-0.301	0.086
UK	0.492	0.170	0.111	0.090

FIGURE 1. A Map of Provincial Border Effects

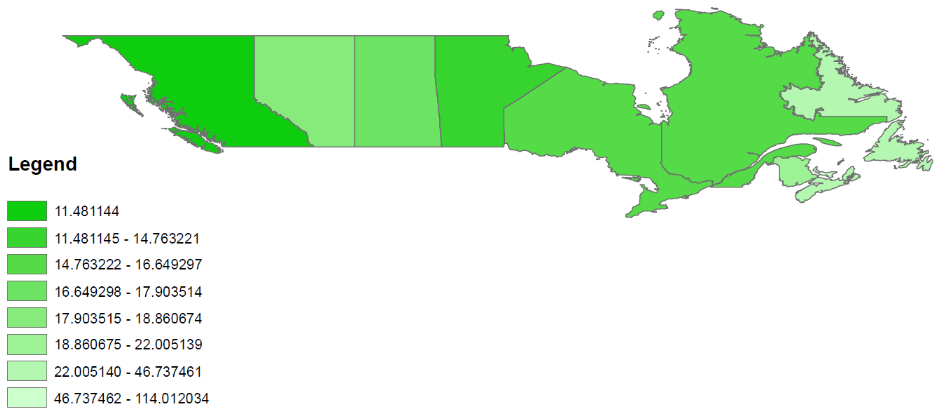


FIGURE 2. A Map of State Border Effects

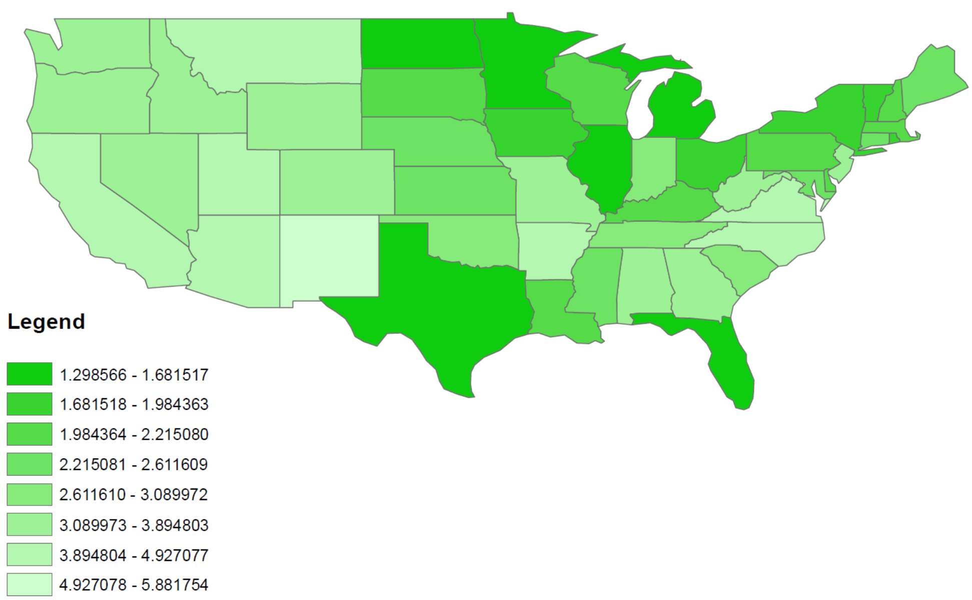


FIGURE 3. Graph of the Implied Border Effect Over Various Importer Market Sizes

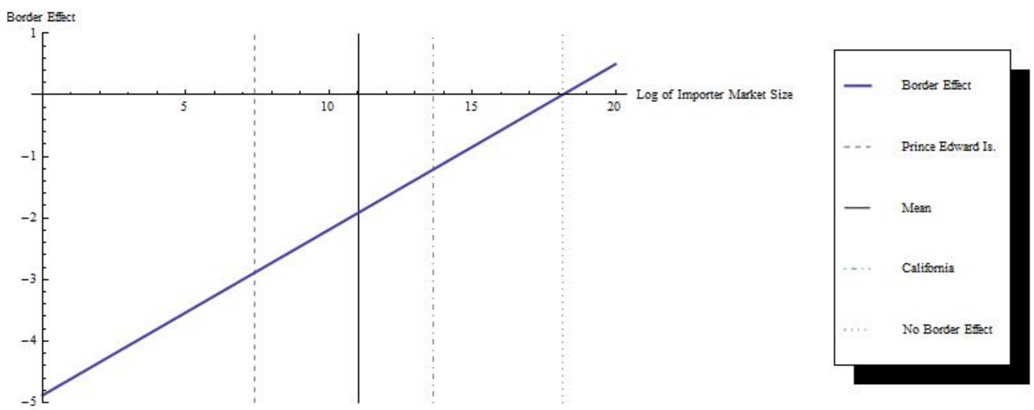


FIGURE 4. Imports and Exports Before and After Joining the EU - Austria and Bulgaria

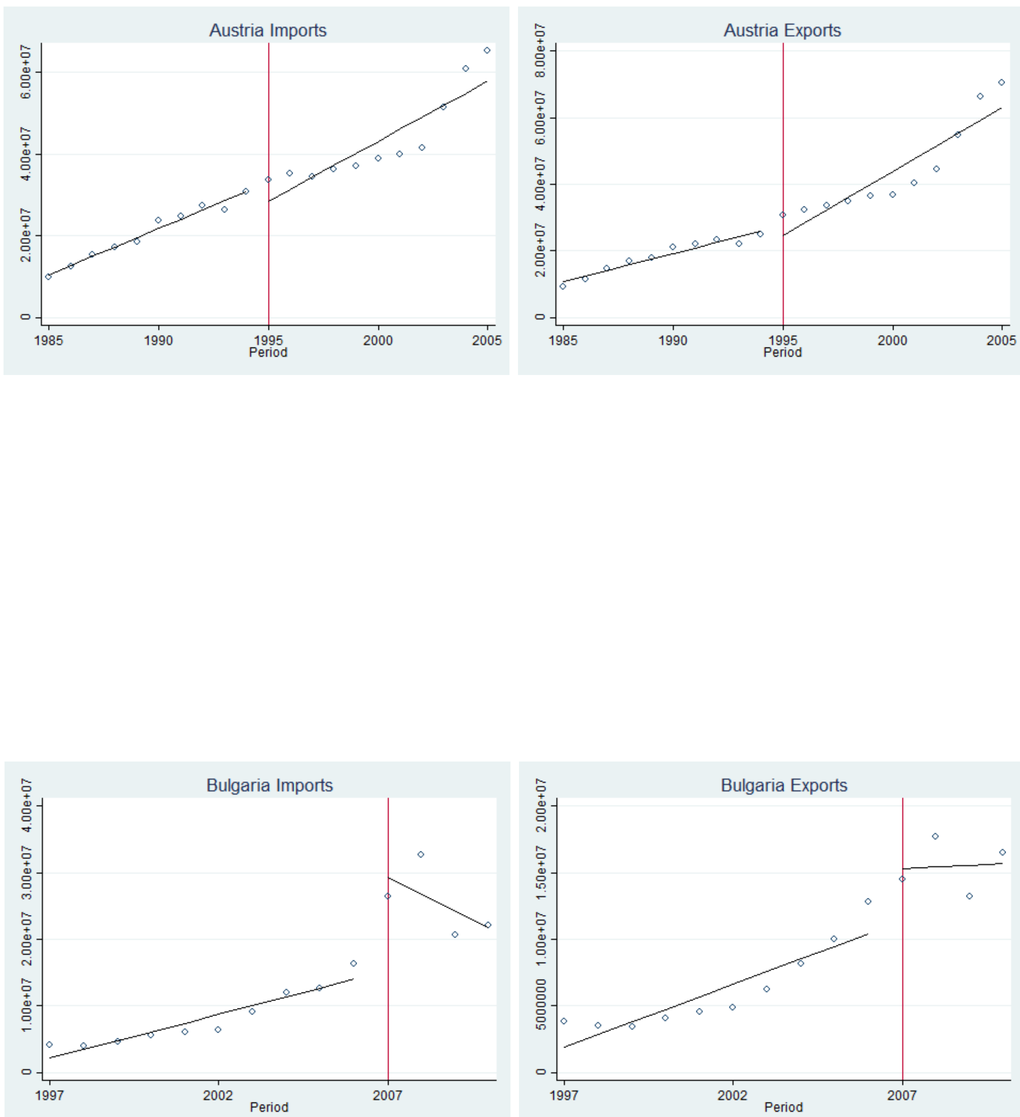


FIGURE 5. Imports and Exports Before and After Joining the EU - Cyprus and Czech Rep.

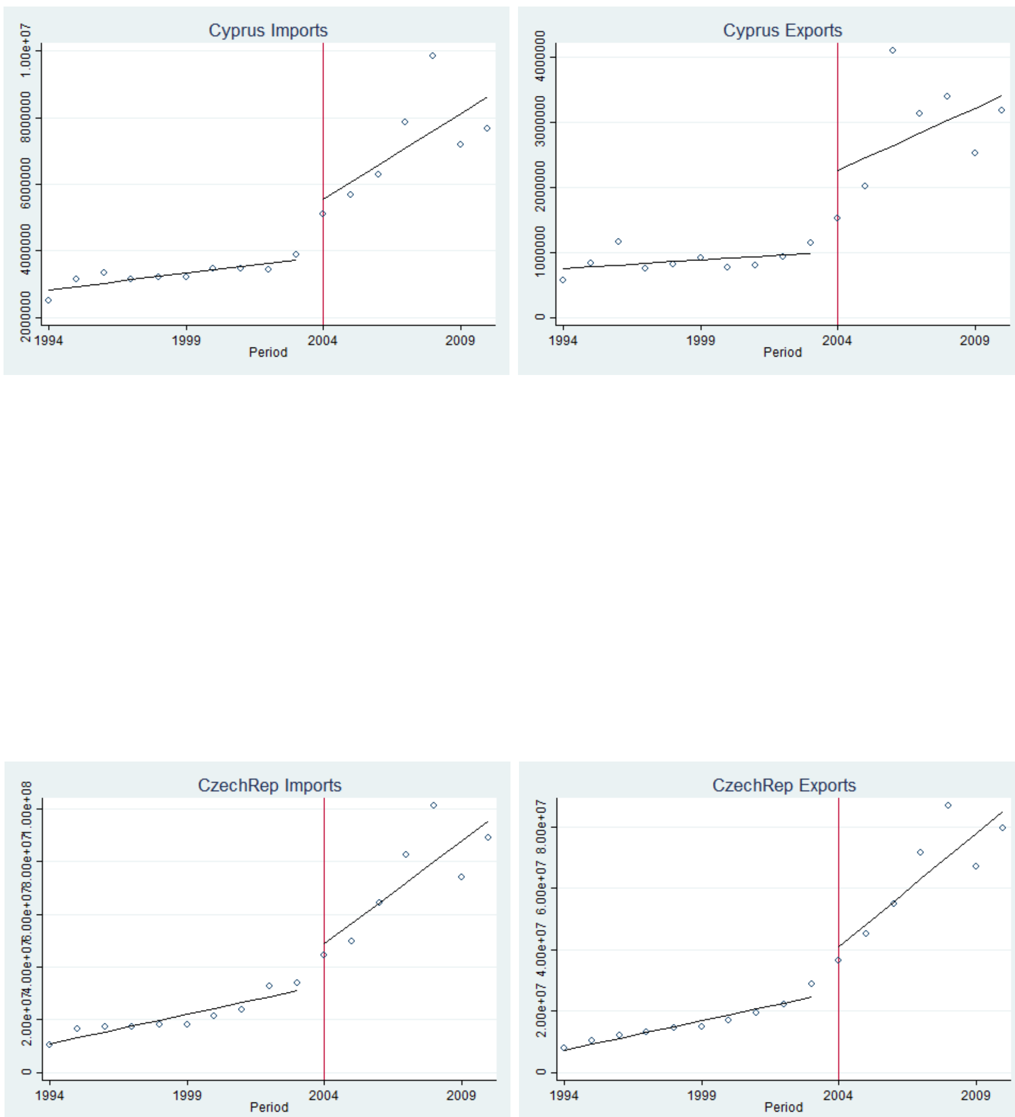


FIGURE 6. Imports and Exports Before and After Joining the EU - Denmark and Estonia

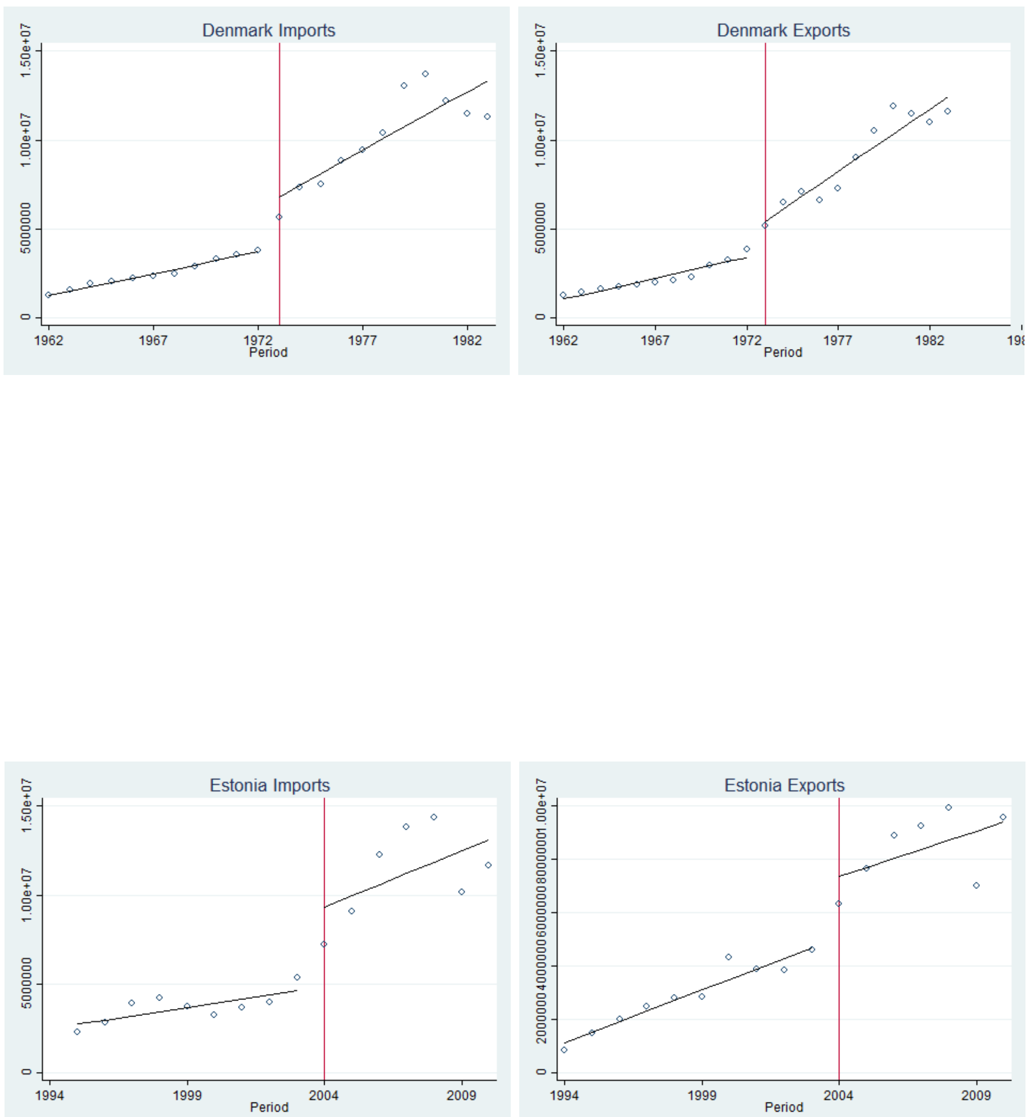


FIGURE 7. Imports and Exports Before and After Joining the EU - Finland and Greece

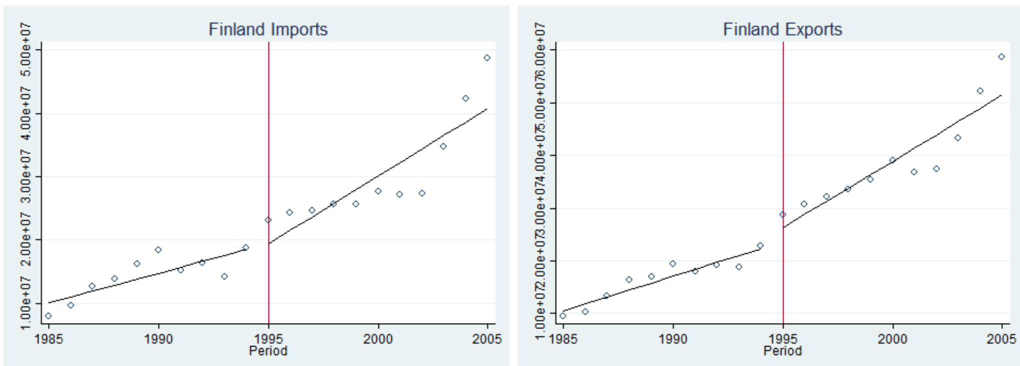


FIGURE 8. Imports and Exports Before and After Joining the EU - Hungary and Ireland

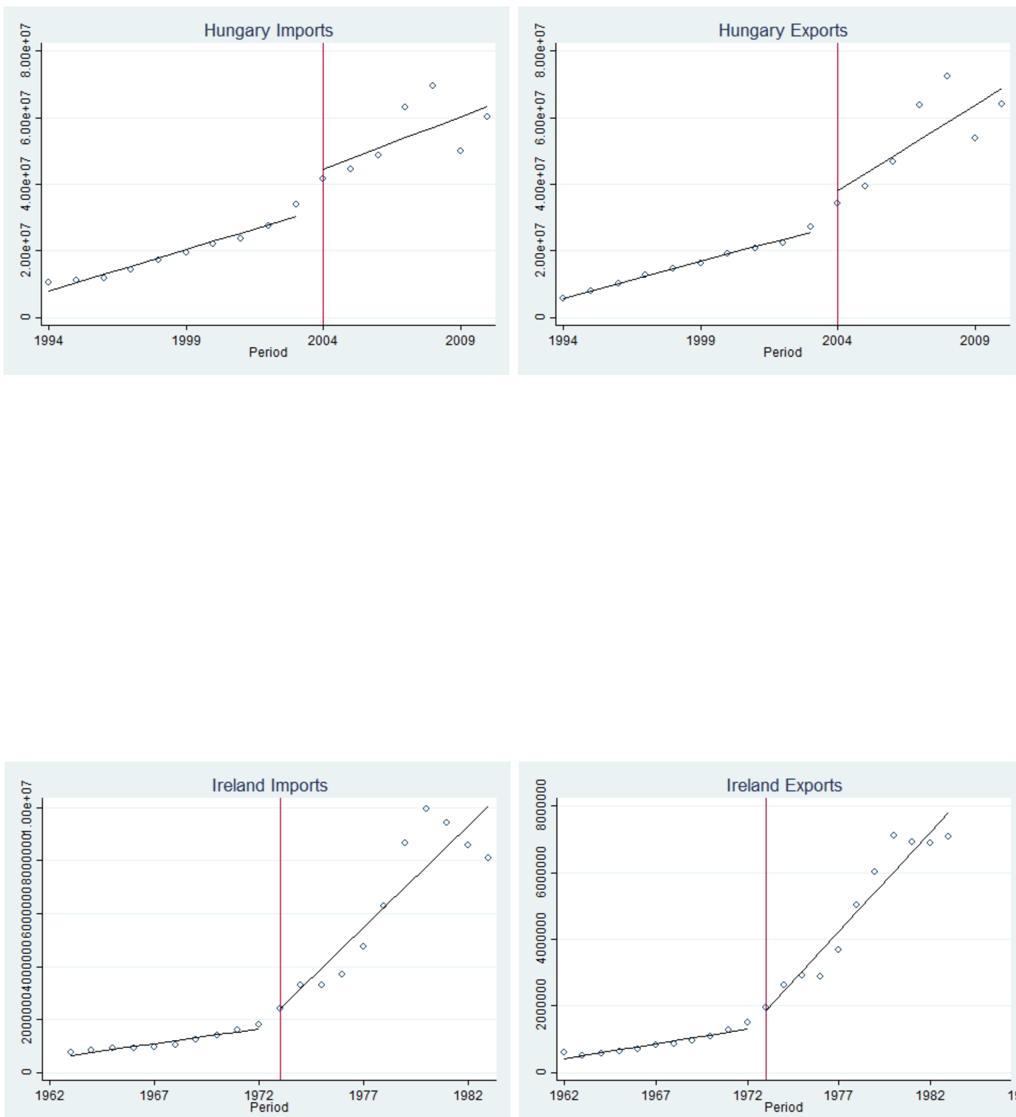


FIGURE 9. Imports and Exports Before and After Joining the EU - Latvia and Lithuania

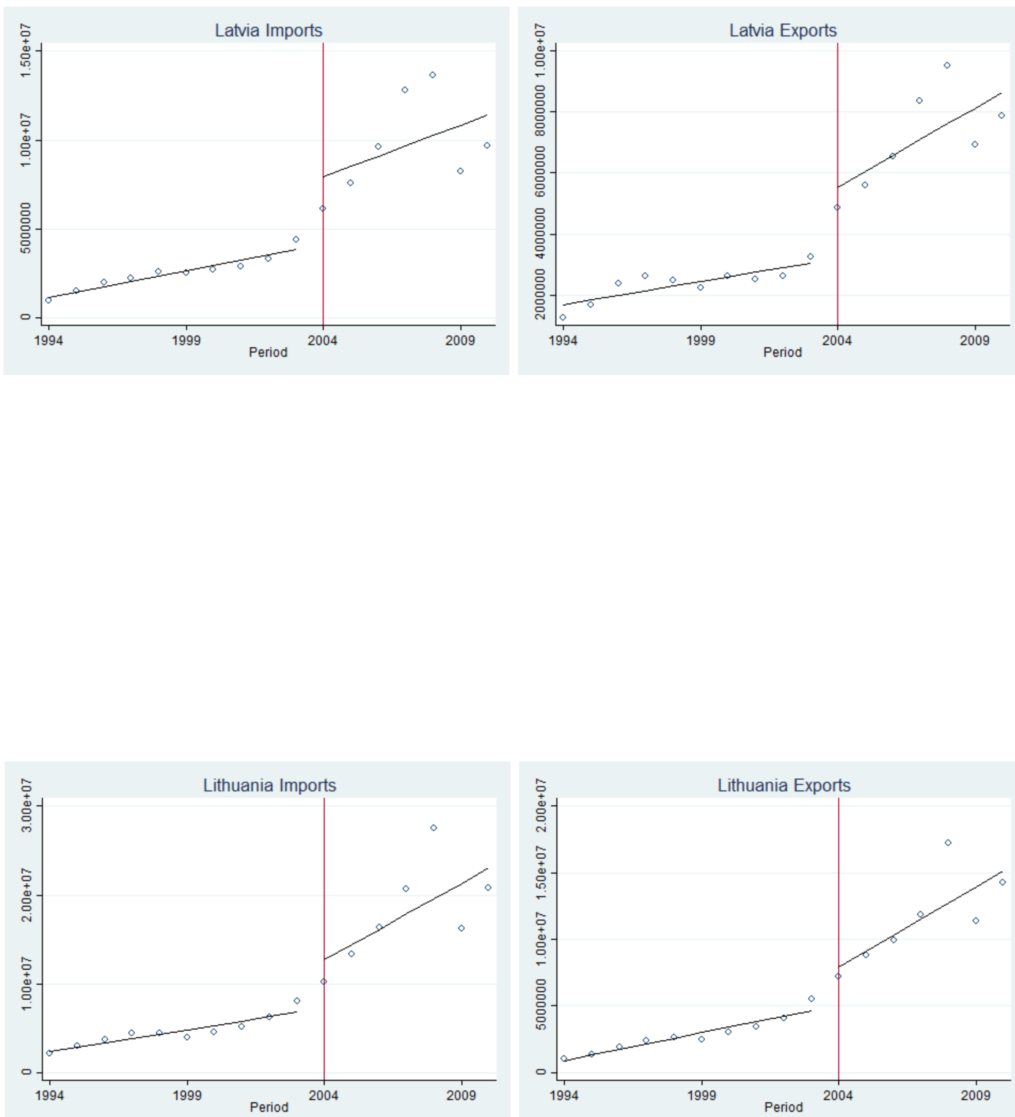


FIGURE 10. Imports and Exports Before and After Joining the EU - Malta and Poland

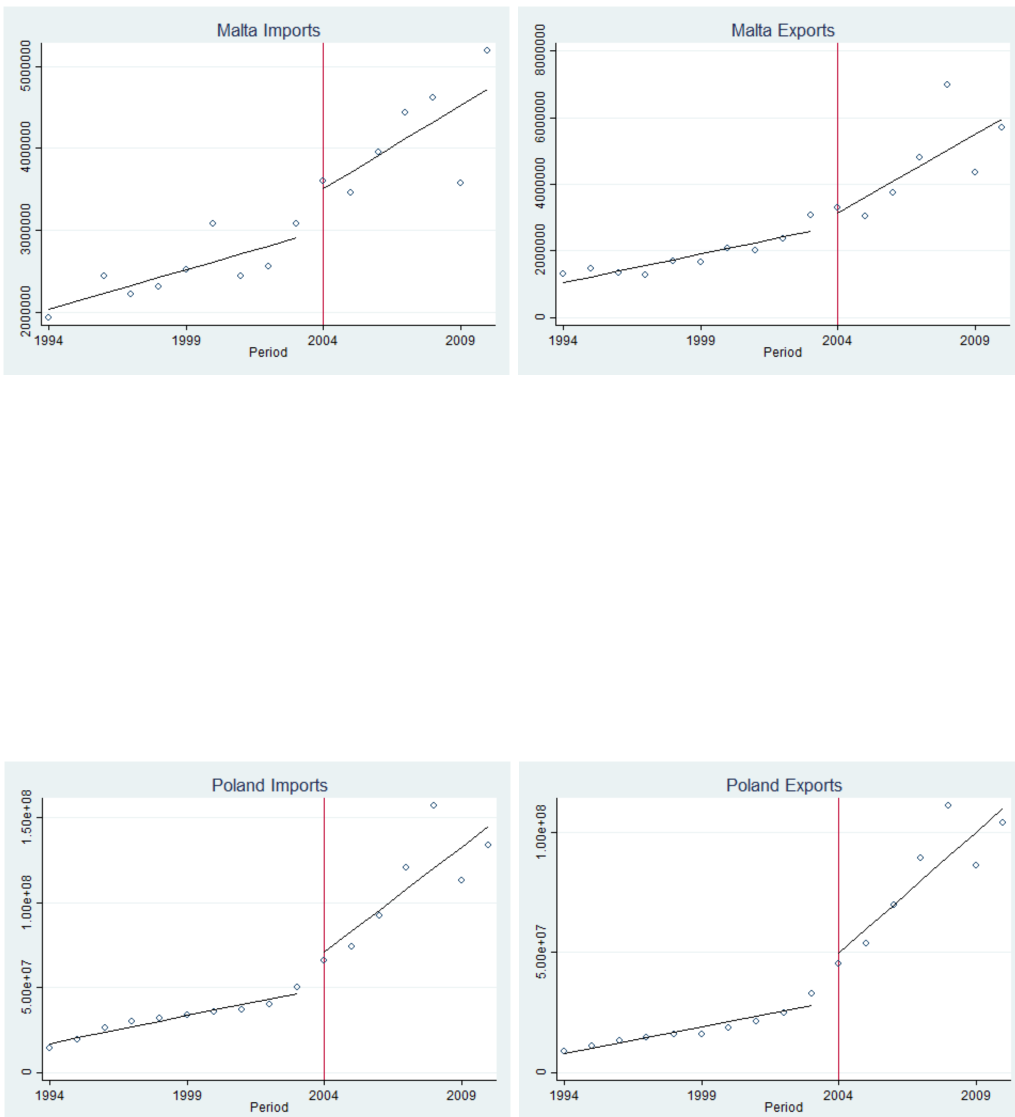


FIGURE 11. Imports and Exports Before and After Joining the EU - Portugal and Romania

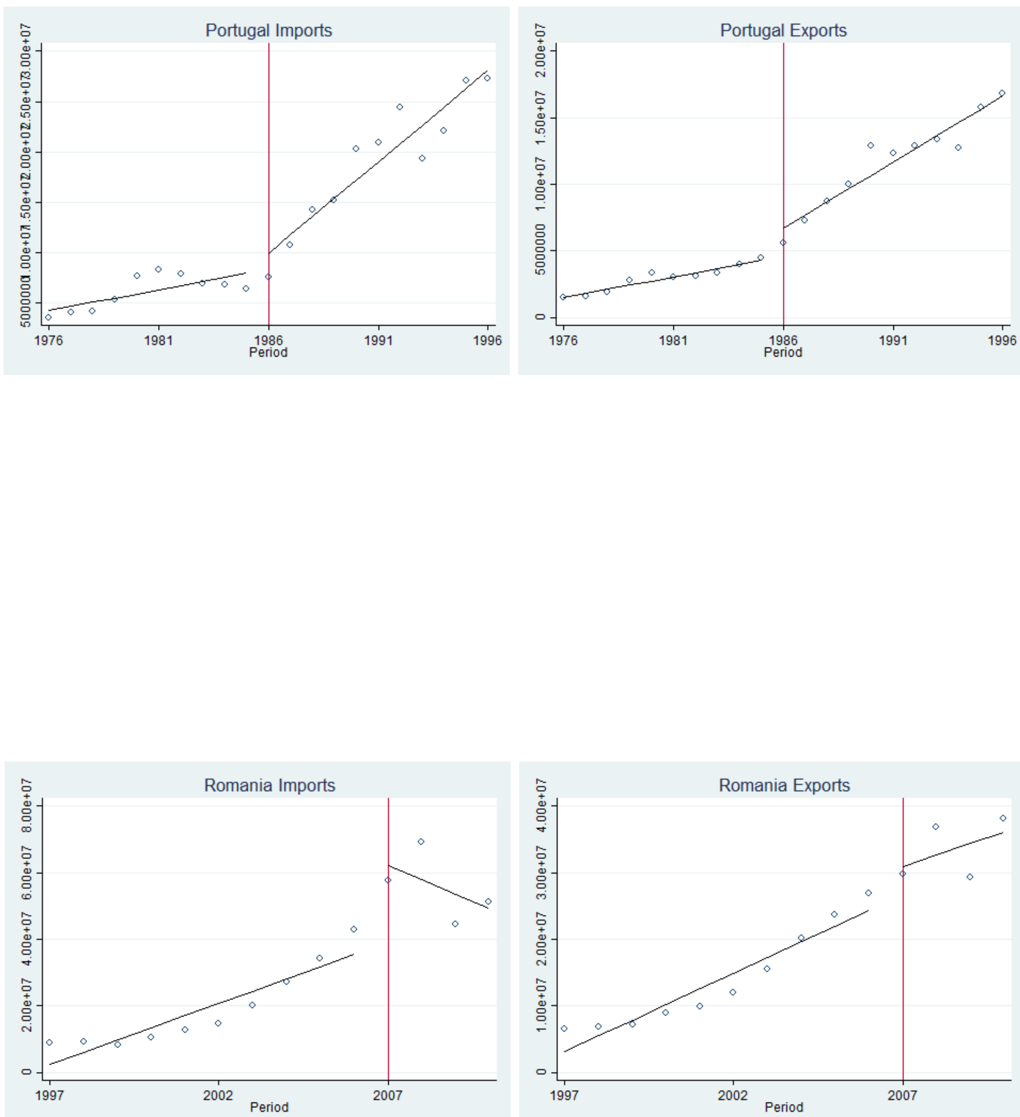


FIGURE 12. Imports and Exports Before and After Joining the EU - Slovakia and Slovenia

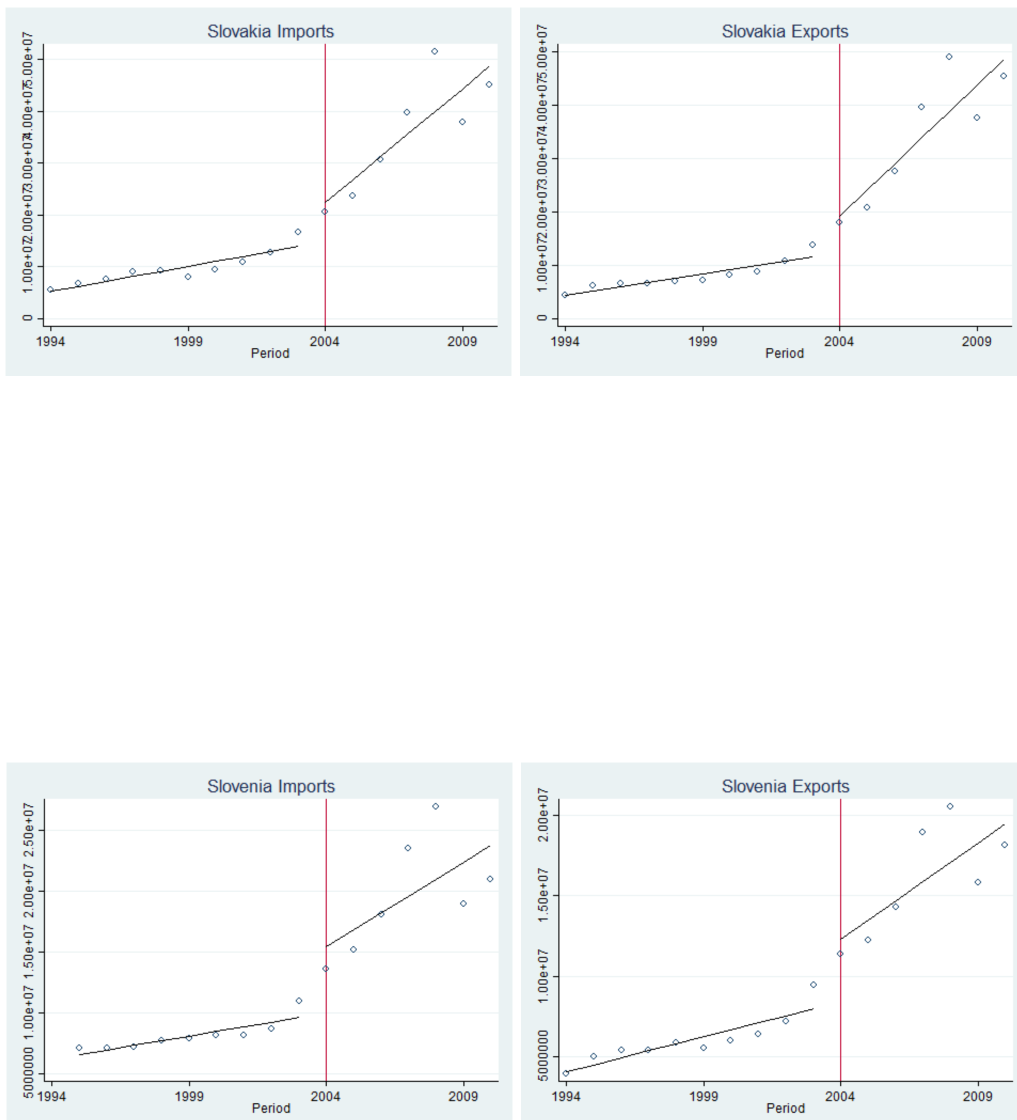


FIGURE 13. Imports and Exports Before and After Joining the EU - Spain and Sweden

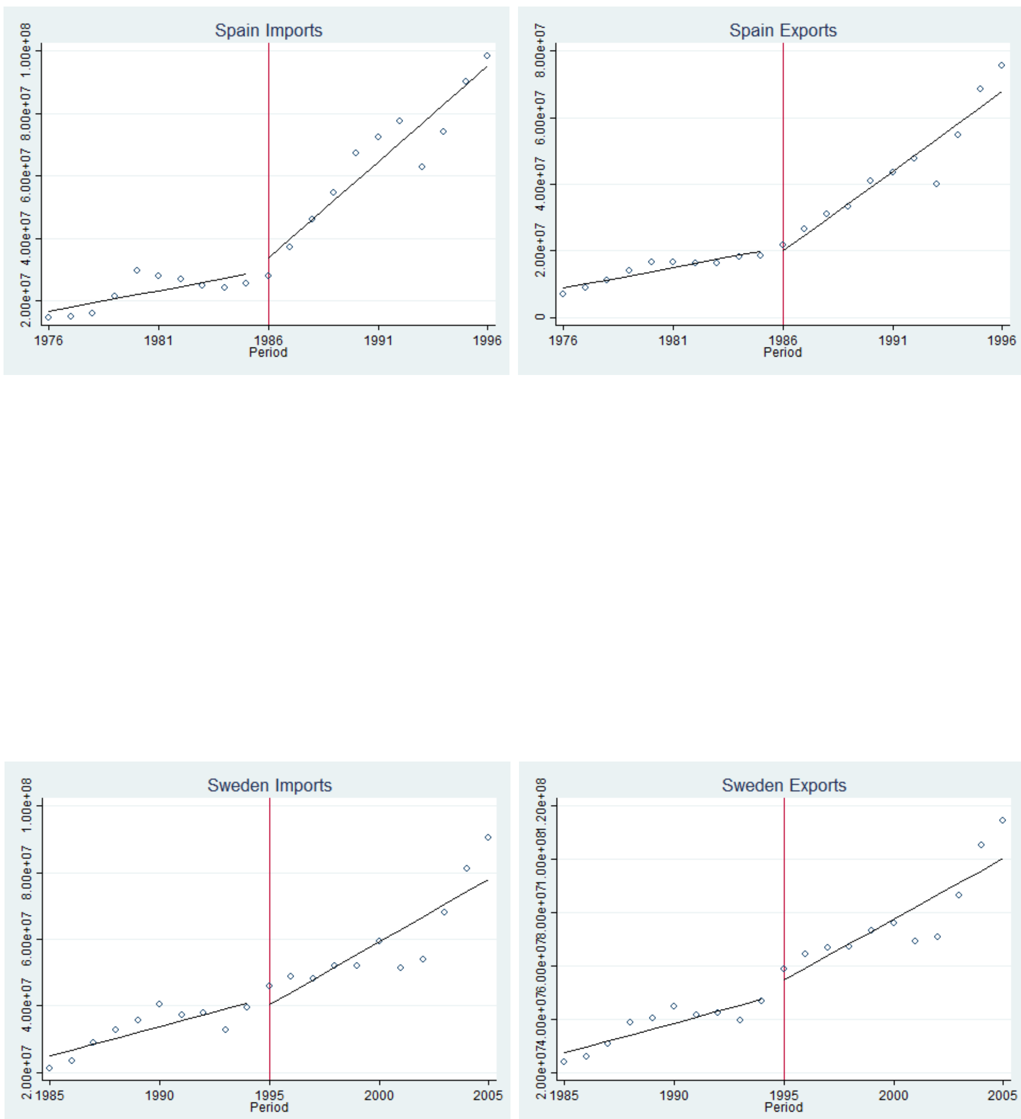
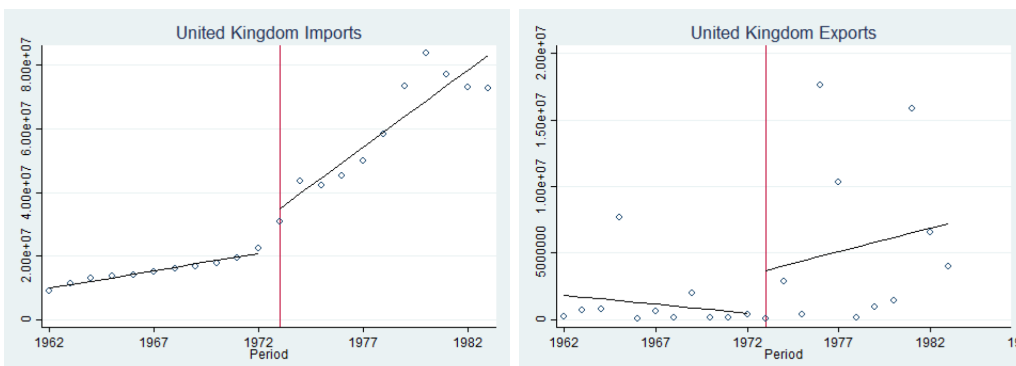


FIGURE 14. Imports and Exports Before and After Joining the EU - United Kingdom



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