THE EFFECT OF ORGANIC PRICE PREMIA AND EQUIVALENCE AGREEMENTS ON SELECT ORGANIC IMPORTS INTO THE UNITED STATES

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ABSTRACT

This thesis estimates a gravity trade model using new USDA Foreign Agricultural Service organic trade data and domestic organic and conventional prices for wheat, corn, and soy from the Mercaris data company. The study empirically analyzes the effect of equivalence agreements on wheat, corn, and soy imports into the US. Further, the price premium of organic goods is used to proxy for restrictiveness of domestic organic supply of the above-mentioned commodities.

Following the example of Bergstrand (1985), I derive the trade flow of one good by optimizing a constant elasticity of substitution utility function for the importing country and constant elasticity of transformation supply function for the exporting country subject to national income constraints. I allow for consumers to choose between an organic good, a conventional good, and all other goods. I find that organic imports depend on exogenous domestic prices of conventional and organic goods, national incomes, populations of both countries, and transport costs.

I estimate a gravity trade model using a Poisson model using crop fixed effects and heteroskedasticity-robust standard errors. The Poisson model is more appropriate than the traditional log-normal OLS estimation for the data set due to a large number of zero-value observations. Data limitations also preclude the use of a Heckman selection model, which is used in Bergstrand and Baier (2002) and Da'ar (2011). The estimation results are generally consistent with theory. Organic imports into the United States are positively associated with exporter income and exporter population, but are negatively associated with distance. The organic to conventional price ratio has a positive and significant effect on organic imports, indicating that as domestic prices for organic wheat, corn, or soy rise relative to the conventional substitute, the US increases imports. The effect of equivalence agreements cannot be directly measured using the data available. As expected due to data limitations, there is no significant effect of equivalence agreements on organic imports into the United States.

TABLE OF CONTENTS

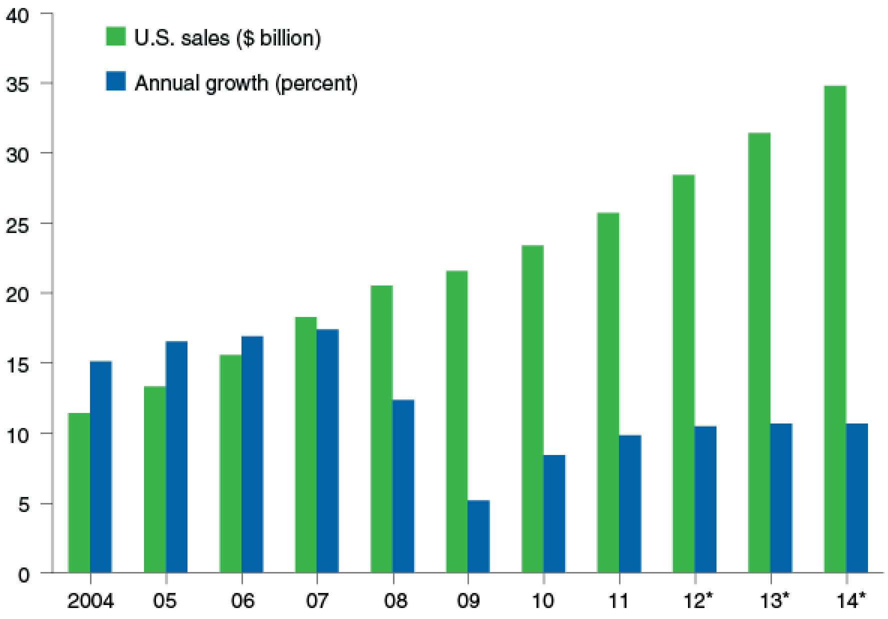
LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

USDA organic standards have supported rapid growth of organic food sales in the United States. In the early 1990's, shortly after the US Organic Foods Production Act of 1990, organic sales were estimated to be around one billion US dollars (Organic Trade Association 2011). Until 2009, annual organic sales growth ranged in the double digits virtually every year, and total organic food sales for 2014 are projected to be $35 billion (see Figure 1). In comparison, US total food sales growth has ranged from -7.5 percent to 19 percent since 2004, and organic food sales growth has exceeded total food sales almost every year. Organic products that were once confined to on-farm sales or specialty stores are now widely recognized and available in supermarkets.

Figure 1: US Organic Food Sales, 2004-2014 (Greene 2013)

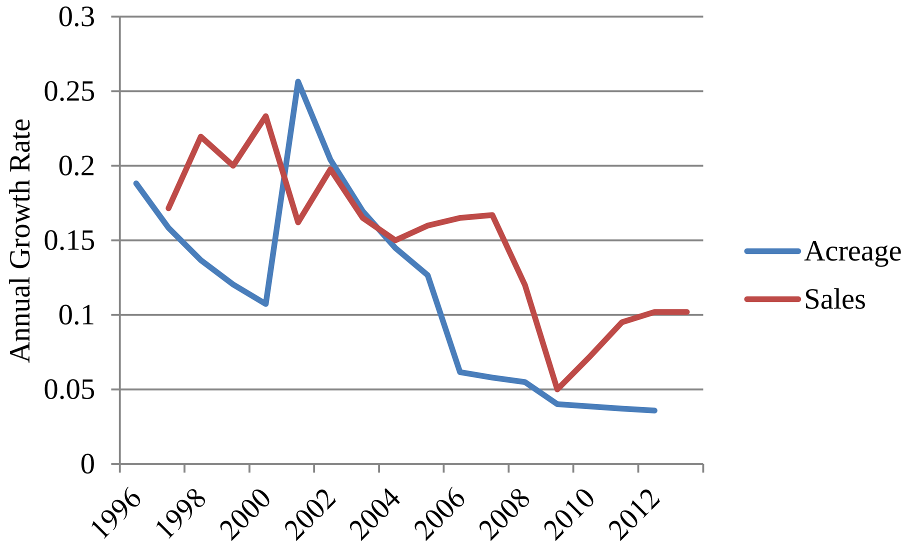


U.S. organic food sales reached $28 billion in 2012

*Estimated.
Source: USDA, Economic Research Service using data from *Nutrition Business Journal*, 2013.

Between 1997 and 2005, organic acreage doubled, and organic acreage grew at an average annual rate of 19 percent between 2000 and 2005 (USDA ERS 2013). While growth in consumer demand for organics shows no sign of slowing, however, certified organic acreage data from the USDA ERS show that the rate of conversion to organic production has fallen below the growth rate of organic food sales (see Figure 2). The US already supplements domestic production with imports to meet consumer demand for organic products, especially tropical and subtropical foods for the past ten years (Greene 2013). If demand grows at a constant rate and transition to organic acreage remains slow, evidence suggests that domestic supply may not keep up with domestic demand.

Figure 2: Percent Change in US Certified Organic Acreage (Cropland and Pasture) in Production and Percent Change in Organic Food Sales, 1996-2014



Sources: Greene (2013), Organic Trade Association (2006), USDA ERS (2013)

The requirements for organic certification create a barrier to entry for many farmers. Certified organic agricultural goods cannot be grown or produced using any methods, ingredients, or chemical substances banned by the Organic Foods Production Act of 1990. The USDA also requires that no banned substances could have been used on the land for 3 years prior to harvesting organic crops. Farmers may incur a loss during the 3 year conversion period from initial reduced yield while still selling at the conventional price. This could explain the inability for domestic organic supply to keep up with demand.

Organic farmers must also create a well-defined buffer zone to prevent contamination from runoff that might carry traces of prohibited substances. The overall goal of the organic requirements is that soil and water resources improve as a result of these practices (US Government Printing Office 2014). For some conventional farmers, the cost of the additional requirements to be certified organic reduces potential returns to conversion.

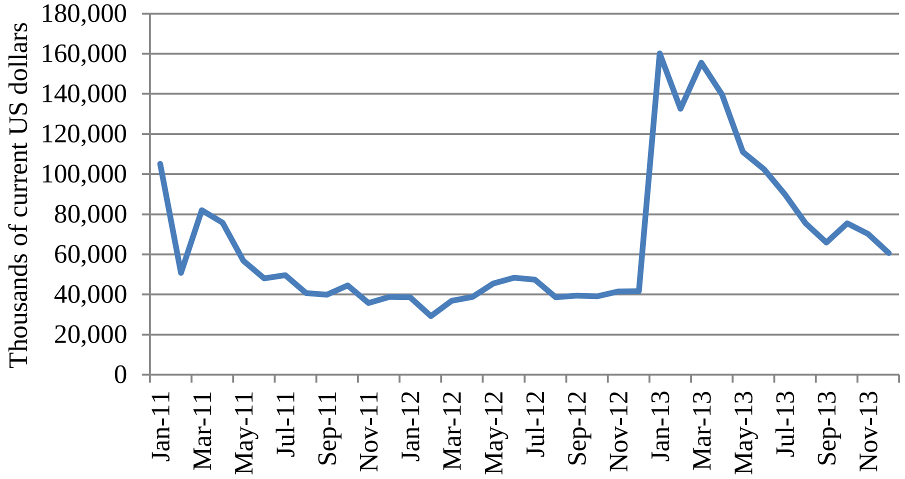
In addition to restrictions to supply due to the transition process, exogenous shocks such as severe weather patterns can further restrict supply. For example, droughts affected the 2012 and 2013 growing seasons in wide areas across the United States, causing a noticeable spike in corn imports. In 2012, up to 57 percent of cropland in the US experienced severe drought (USDA ERS 2012). While droughts affect both organic and conventional crops, organic product markets are less liquid than conventional markets and so stochastic shocks to supply could affect organic prices to a greater extent relative to conventional prices.

Organic foods generally command a significant price premium over conventional substitutes because of perceived higher quality and improved food safety, as well as environmental values. Higher prices also reflect higher production costs. The willingness to pay literature for organic products estimates that North American consumers find a price premium of 5 to 40 percent above the conventional substitute acceptable (Yiridoe, Bonti-Ankomah, and Martin 2005). A study of UK consumers suggests that the willingness to pay for organic goods is more closely related to the price premium than to absolute price of the organic good (Beharrell and MacFie 1991). Though price premia are at times volatile, organic grains and oilseeds sold for twice the price of conventional from 1995 to 2003 (Born 2005). The price premium of organic goods contains useful information about the supply-demand balance for organic products. Consumers often base their purchase decisions on the relative price of organic to the conventional substitute, so a price ratio for organic commodities can be a good proxy for the size of the gap between domestic supply and demand for organics.

Excess demand for organic products must be met by imports. Unfortunately, import data for organic agricultural products was not consistently measured until 2011. Organic imports since then have been highly varied (see Figure 3), but trade volumes overall are high and slighting increasing.

The main issues with importing organic products are differences in organic standards across nations and uncertainty of proper certification. The National Organic Program requires exporters to use an accrediting agency recognized by the US to grant certification according to USDA standards before their products can be imported into the United States.

Figure 3: Value Total Organic Imports into the United States, 2011-2013

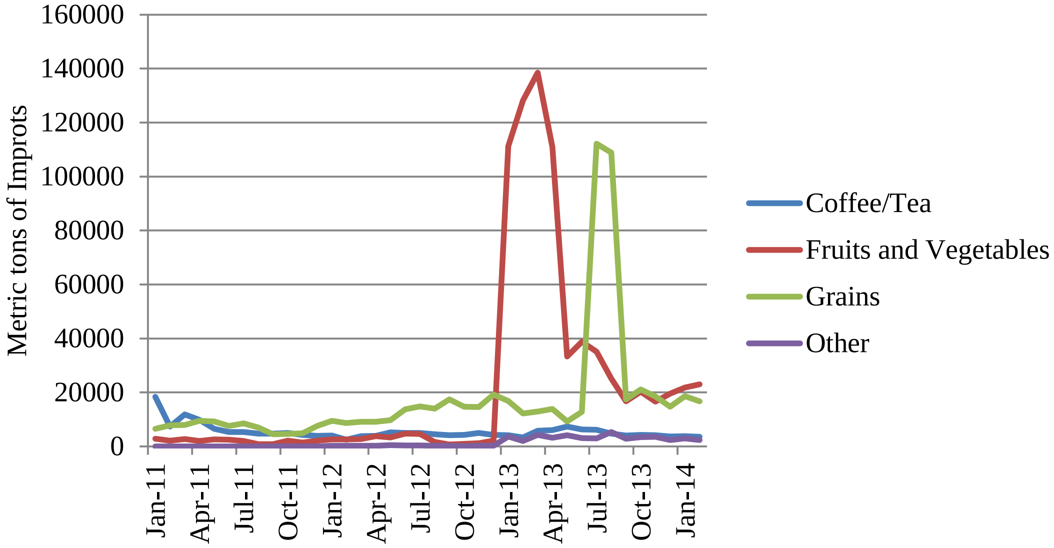


Source: USDA FAS (2014).

While it is difficult to identify a meaningful trend from the import data collected by the FAS so far, decomposing total imports into categories reveals that organic grains and produce imports have been increasing in quantity since 2011 (see Figure 4). Imports of organic bananas were not recorded until 2013, however, which explains a large spike in fruits and vegetables imports in the earlier part of that year. Coffee and tea imports are stable, if not slightly decreasing, as are products in the “other” category, which includes olive oil and honey.

Of particular interest is the grains category, which is the focus of this study. Organic soy and corn are for the most part used as feed crops for livestock, especially dairy cows, with some direct consumption of soy as frozen edamame. Dairy accounts for 15 percent of total organic market share as of 2012 (Greene 2013). Wheat is also generally an intermediate good used in organic pastas and breads. I choose wheat, corn, and soy as the focus for this study because there is steady demand and available price data for these crops.

Figure 4: Organic Imports by Product Category in Metric Tons, 2011-2013



Source: USDA FAS (2014).

In order to address concerns about the consistency of organic standards across countries, the US Government established equivalence agreements with Canada in 2009 and the European Union in June 2012. In addition, the US has recognition agreements with New Zealand, India, United Kingdom, Japan, Israel, and Denmark (Agricultural Marketing Service 2014, USDA 2012). The distinction between equivalence and recognition agreements is that equivalence agreements allow operations and products certified as organic in either country to be labeled as organic in both countries, while "recognition agreements allow a foreign government to accredit certifying agents in that country to the USDA organic standards" (USDA Agricultural Marketing Service 2014). These agreements are designed to reduce transaction costs for foreign producers seeking to be certified organic by USDA standards and export to the US, while also providing assurance to consumers about the consistency of the organic label. This study will look specifically at equivalence agreements because they are more comprehensive in the harmonization of standards than recognition agreements.

Despite organic trade agreements and certification requirements for imports, uncertainty about accurate information can be problematic for consumers when purchasing imported organic goods. Caution is exercised especially in the case of organic food products, such as ginger root and frozen edamame (soybeans), from China, where the food system has experienced a number of publicized food safety issues (Allison 2011). Any organic foreign imports carry more perceived risk for the consumer, which could cause imports to increase only in times of dramatic shortages in domestic supply, even if import prices are lower than domestic prices.

In 2011, the Foreign Agriculture Service (FAS) introduced codes for imports and exports of select organic products. Using these codes, monthly import and export values and quantities are recorded and made available to the public. The Mercaris Data Company has also been collecting organic and conventional prices for select coarse grains and commodities. These new and growing datasets represent a helpful starting point for understanding what factors encourage or discourage organic trade for the United States. In particular, do equivalence agreements significantly increase trade between country pairs? Does the relative price of organic goods to conventional serve as a proxy for the effect of excess demand on organic imports of organic yellow dent corn, soybeans, and durum wheat into the US?

Empirical trade studies frequently rely on the gravity trade model to examine patterns of international trade. A number of papers have previously used the gravity trade model (hereafter referred to as GTM) to estimate the effects of free trade agreements and other preferential trade arrangements on trade flows between countries (Aitken 1973, Baier and Bergstrand 2002, Carrere 2006). These papers often struggle with the endogeneity problem of countries selecting into trade agreements according to observed and unobserved characteristics. However, these papers have still established the utility of the GTM model for estimating the additional effect of trade agreements on trade flows.

Evidence from the gravity trade model can inform us about the properties of the organic coarse grains market, the effect of equivalence agreements if any exists, and an investigation into the relationship between the restrictiveness of US organic supply and organic imports.

This study has three objectives: (1) assemble a dataset of organic trade data that has not yet been used in the gravity trade literature, (2) fit the data to a traditional gravity trade model, (3) expand the traditional model to estimate (a) the effects of trade agreements specific to organics standards and (b) the effects of domestic price premia of the importing country. In meeting these objectives, this study establishes a baseline for using the Foreign Agriculture Service's organic trade data and Mercaris Data Company's organic and conventional price data for future research. The results of this study provide a basis for initial understanding of organic trade data, and the paper poses hypotheses to test after more data has been collected.

The next chapter briefly discusses the previous literature of the gravity trade model, outlines the theoretical approach best suited to accomplish the research objectives, and finally the econometric models I apply. The third chapter describes the data and sources of the data used in the estimation. I present the estimation results of the Poisson specification and analyze the implications for the research objectives in the fourth chapter.

I conclude with further implications and suggestions for future research in the fifth chapter.

CHAPTER 2: METHODS

The vast majority of empirical trade volume studies employ the gravity trade model because the specification repeatedly returns consistent and interpretable results. Many approaches have been taken using the gravity trade model. The model originates using the physics equation for gravity, based upon the idea that countries with greater "mass", in terms of population and purchasing power, will trade more with each other, though the attraction dissipates as distance increases (Equation 1). In the first few decades of use, starting with Tinbergen (1962) and advanced by Linnemann (1966), the model was used without an explicit foundation in economic theory.

The general approach to a gravity trade model is to predict the value of trade flow from exporter *i* to importer *j*. In a theoretical world with two countries, the trade volume would be the difference between total domestic potential supply and total domestic potential demand for a good in country *i* at the price at which markets clear. Linnemann (1966) defines the volume of trade flows as a function of the incomes and populations of both countries and transport costs. The most simplified version of the gravity trade model takes the form:

$$M_{ij} = k\frac{{Y_i}^{\beta_1}{Y_j}^{\beta_2}{N_i}^{\beta_3}{N_j}^{\beta_4}}{{D_{ij}}^{\beta_5}} \tag{1}$$

where k is a proportionality constant, Y_i and Y_j are national incomes, N_i and N_j are national populations, and D_{ij} is a physical or cultural distance between country *i* and *j* .

Attempts to identify a structural model basis for the GTM include probabilistic models and traded-goods expenditures shares equations (Leamer and Stern 1970, Anderson 1979). Both probabilistic models and traded-goods expenditures shares equations base the structural foundation on expenditure share of total national income on imports to estimate inflows. This study, along with other recent papers (Bergstrand 1985, Carrere 2006, Da'ar 2011), advances the constant elasticity of substitution utility function and constant elasticity of transformation supply function to explain total potential demand and supply, respectively, of one importing country and one exporting country.

Bergstrand (1985) defines the domestic demand of the importer as a constant elasticity of substitution (CES) utility model, assuming homothetic preferences. The exporting country's supply is a constant elasticity of transformation (CET) function to mirror the functional form of the importer's utility function. The CET structure assumes that there is monopolistic competition among exporting firms, which is a fitting assumption for the organics market – there is a small degree of branding and barriers to entry which distinguish organics from conventional agricultural production.

Bergstrand's model also uses the Armington assumption that there are differences in products depending on the location of production. I use this setup to define homothetic utility for the importing country *i* as a function of domestically produced organic goods X_{ii} , foreign-produced organic goods X_{ij} , the conventional substitute C_i , and all other consumable goods A_i .

$$U_i = \{(X_{ij}^{\alpha} X_{ii}^{1-\alpha})^{\psi} + C_i^{\psi} + A_i^{\psi}\}^{1/\psi} \tag{2}$$

where $\psi = (\mu-1)/\mu$, and μ is the elasticity of substitution between the conventional good, organic good, and all other goods, regardless of origin. For the purposes of this study, I assume Cobb-Douglas characteristics for the substitution of foreign and domestic organic goods, where the elasticity of substitution σ is one. Equation 2 is optimized according to the country's budget constraint with national income Y_i :

$$Y_i = P_{xii}X_{ii} + \left(P_{xij} + T\right)X_{ij} + P_{ci}C_i + P_A A_i \tag{3}$$

where *T* represents transport costs or any other cost associated with trade that the importing country incurs, P_{xii} is the price of organic goods in the importing country, P_{xij} is the import price, P_{ci} is the domestic price of conventional goods in country *i*, and P_A is the average price of all other goods. All other goods *A* together represent the Hick’s numeraire good, meaning that all other prices are relative to P_A¸ so P_A is equal to one. The resulting demand for imported organic goods X_{ij}^{D} is a function of prices, transport costs, national income, and the elasticity of substitution between conventional and organic goods.

$$X_{ij}^{D} = Y_i \left\{ \begin{array}{c} \left(P_{xij} + T\right) + \left[\frac{(P_{xij}+T)(1-\alpha)}{\alpha}\right] \\ + \left(P_{ci} + P_{ci}^{1-\psi}\right)\left[\left(\frac{(1-\alpha)P_{ci}}{P_{xii}}\left[\frac{(P_{xij}+T)(1-\alpha)}{\alpha(P_{xii})}\right]^{1-\alpha}\right)^{\frac{1}{\psi}-1}\left[\frac{(P_{xij}+T)(1-\alpha)}{\alpha(P_{xii})}\right]^{1-\alpha}\right] \end{array} \right\}^{-1} \tag{4}$$

The elasticity of substitution is allowed to differ between organic and conventional goods because of perceived quality differences by consumers. The quality difference is essential because, if organic and conventional goods contributed equally to utility, there would be a corner solution of all conventional goods because of a lower conventional price.

Domestic supply of the exporting country is characterized by a constant elasticity of transformation function, where there exists one universal and immobile resource R_j with factor price W_j . R_j is defined as:

$$R_j = \{(X_{ij}^{\phi}X_{jj}^{1-\phi})^{\delta} + C_j^{\delta} + A_j^{\delta}\}^{1/\delta} \tag{5}$$

where X_{ij} represents the production of country *j* for export markets, X_{jj} is production for domestic markets, C_j is the production of a conventional substitute, A_j is the production of all other goods in the exporter's economy, and $\delta = (1+\eta)/\eta$ where η is the elasticity of transformation between conventional and organic goods. The resource R_j can be used in the production of any good. Like the importing country utility model, organic production in country j is assumed to have Cobb-Douglas properties. Firms maximize profits:

$$\Pi_j = P_{xjj}X_{jj} + P_{xij}X_{ij} + P_{cj}C_j + P_A A_j - W_j R_j \tag{6}$$

where P_{xij} is the export price, P_{xjj} is the domestic price for organics in country j, and P_{cj} is the price of the conventional substitute. Profits are maximized according to the national income constraint:

$$Y_j = W_j R_j \tag{7}$$

From Equations 6 and 7 I derive the supply of organic goods for export from country j , X_{ij}^S :

$$X_{ij}^S = \frac{Y_j}{W_j}\left\{\begin{matrix} \left[\frac{P_{xij}(1-\phi)}{\phi P_{xjj}}\right]^{\delta(1-\delta)} + \\ \left[\left(\frac{(1-\phi)P_{cj}}{P_{xjj}}\left[\frac{P_{xij}(1-\phi)}{\phi P_{xjj}}\right]^{-\phi}\right)^{\frac{1}{\delta}-1}\left[\frac{P_{xij}(1-\phi)}{\phi P_{xjj}}\right]^{1-\phi}\right]^{\delta} (1 + \left[\frac{P_A}{P_{cj}}\right]^{\frac{1}{\delta}-1} \end{matrix}\right\}^{-1/\delta} \tag{8}$$

In this theoretical world with two countries, one can use the identity (Equation 9) that import demand is also export supply,

$$X_{ij}^D \equiv X_{ij}^S \equiv X_{ij} \tag{9}$$

where X_{ij} represents the total trade flow between the two countries.

The gravity trade literature relies on the assumption that each country-pair trade flow is small compared to total world trade, so that effects on prices is negligible and domestic prices are exogenous. Bergstrand (1985) solves for the import price P_{xij} as a function of national incomes, transport costs, and domestic prices. Then Bergstrand (1985) substitutes P_{xij} into X_{ij} to find that trade flows are a function of the national incomes of countries i and j , domestic prices, transport costs, and elasticities. Assuming perfect commodity arbitrage, P_{xii} and P_{xij} are constrained to be equal, as are P_{ci} and P_{cj}. Where most gravity trade analyses disregard prices or proxy relative price levels through GDP or a related income variable, this study proposes that the price of a substitute has a large effect on demand for organic products. The ratio of the domestic price for an organic good to the domestic price of the conventional substitute, according to the framework above, should have a positive effect on organic import demand, if domestic prices are exogenous.

The resulting specification for a log-normal gravity trade model is represented by Equation 10:

$$\ln M_{ijc} = \beta_0 + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln N_i + \beta_4 \ln N_j + \beta_5 \ln D_{ij} + \ln \varepsilon_{ijc} \tag{10}$$

where M_{ijc} represents the trade volume for crop c, to importer i from exporter j, Y_i (N_i) and Y_j (N_j) are the national incomes (populations) of the importer and exporter, respectively, D_{ij} is the distance in kilometers between the economic centers of the country pair, and ε_{ijc} is the random disturbance term.

The typical results of a gravity trade model find that trade flows increase with the incomes and populations of both trading partners. Income and population represent demand in the importing country, while these factors represent the production capacity of the exporting country. In the case of agricultural products, the amount of cultivated land could also be an indicator of production capacity. Higher domestic demand could reduce the amount of a good an exporting country can offer to the rest of the world. Therefore, the income and population of the origin nation could have ambiguous coefficient signs. Some studies use income per capita in place of population to measure production capacity in the exporter and demand in the importer (Bergstrand 1989, Eichengreen and Irwin 1998, Da’ar 2011). However, Linnemann (1966) argues against this because including both national income and income per capita in the model introduces multi-collinearity among other issues.

The most common trade resistance term is distance, often measured by the number of miles or kilometers between economic centers or capital cities. Other approaches are also average transport distances, weighting by population density, adjacency, and a dummy variable to indicate if either trading partner is a landlocked country. Carrere (2006) proxies a barrier to trade function with relevant geographic variables and a measure of infrastructure development. Other than sharing a border and infrastructure, the coefficients of these terms are expected to be negative.

In the same spirit as a trade resistance term, previous research has used the gravity trade model to measure the effect of trade agreements (Aitken 1973, Bergstrand 1985, Bergstrand 1989, Baier and Bergstrand 2002, Carrere 2006). Trade agreements are typically expected to encourage trade by reducing the cost of trading, but results are sometimes inconclusive and often complicated by endogeneity. Even if not the focus of a study, binary variables for free trade agreements are typically included as controls.

Aitken (1973) and Bergstrand (1985) find evidence for positive effects on trade for membership in the European Economic Community and European Free Trade Association in the mid-20th century, though the positive results of Bergstrand (1985) are insignificant for the EEC membership. Carrere (2006) tests for numerous regional trade agreement effects on trade volumes, but finds that the EU preferential trade arrangement has a negative effect on intra-EU trade for some periods, negative or insignificant effects for MERCOSUR, and generally positive effects for NAFTA and ASEAN. However, the coefficients are not robust to estimation methods. The inconsistent estimation results, as (Baier and Bergstrand 2002) discuss at length, can be traced to the endogeneity of countries selecting into trade agreements and the fact that nations with trade agreements tend to have similar characteristics that are already trade-encouraging.

Though the gravity model itself is relatively simple, the properties of trade flow datasets cause major econometric issues for virtually all GTM studies. Foremost is the problem of zeroes. Zero values of trade flows often comprise the majority of trade flow observations, as many small countries often do not trade with each other. In the case of this study, and others that estimate using a specific good, many zeroes result because not all countries produce the specific good (Burger et al. 2009). Because the common approach is to estimate a log-normal model, trade volumes with a value of zero are replaced with a one or some arbitrary constant because the log of zero is undefined. The inclusion of zeroes can bias results if they are not randomly distributed, and the magnitude of the arbitrary constant can often change the results. On the other hand, simply omitting zeroes altogether removes valuable information about why two countries do not trade.

Additionally, a number of studies question whether log-normal estimation is the most appropriate model to analyze bilateral trade. As Silva and Tenreyro (2006) and Burger et al. (2009) assert, the gravity trade literature has long ignored how the log transformation of the dependent variable biases OLS estimates downward, and additionally violates the homoskedasticity assumption that error terms have equal variance for all values of the log of trade values. Trade data tend to exhibit elements of heteroskedasticity, which reduces estimation efficiency and consistency of the estimators. Several approaches exist in the literature to remedy these issues.

Burger et al. (2009) rely heavily on a modified Poisson regression model to avoid the bias of the log transformation. Poisson estimates are consistent even with the presence of observed heteroskedasticity. Zero-value trade flows can also be included in the Poisson model because of its multiplicative form. Poisson models are generally used for count data, and can be considered a natural fit for trade flows. If a Poisson specification is, indeed, a more appropriate modeling technique for trade data, then the assumption must be that trade data is Poisson-distributed. A Poisson distribution is a probability density function such that an event, such as positive trading for a certain time period, has a calculable distribution mean. Also, the probability of an event occurring is independent of whether the event happened in the last time period. If this assumption is correct, that would imply that the decision to trade is a direct result of the economic conditions of the importing and exporting country rather than a direct result of whether they traded in the previous period.

The Poisson distribution differs from a normal distribution because a normal distribution has constant variance around the sample mean. Instead, Poisson distributions are probability density functions that must be non-negative, and do not necessarily have constant variance.

In the gravity trade model context, the Poisson model is a maximum-likelihood estimation such that the expected mean of the Poisson distribution is:

$$\theta_{ijc} = E[M_{ijc} \mid X] = e^{\alpha + \beta' X_{ijc}} \qquad (11)$$

where X is the vector of explanatory variables usually included in a GTM (shown below), β is the associated vector of coefficients, M_{ij} is the volume of trade between country *i* to country *j*, and α is a proportionality constant term. The vector of explanatory variables specific to this study is defined as:

$$X = \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln N_i + \beta_4 \ln N_j + \beta_5 \ln D_{ij} + \beta_6 Eq_{ij} + \beta_7 \ln P_{ic} + \beta_8 \ln B_{ijc} + \ln \varepsilon_{ijc} \qquad (12)$$

where Y_i (N_i) and Y_j (N_j) are the national incomes (populations) of the importer and exporter, respectively, D_{ij} is the distance in kilometers between the economic centers of the country pair, Eq_{ij} is the binary variable that is equal to one if country *i* and *j* have an equivalence agreement, P_{ic} is the organic to conventional price ratio in country *i* for crop *c* , and B_{ijc} is a binary variable that is equal to one if positive trade was observed in the previous period between country *i* and *j* in crop *c*, and ε_{ijc} is the random disturbance term.

The Poisson specification takes the form of:

$$\Pr[M_{ijc}] = \frac{{\theta_{ijc}}^{M_{ijc}} e^{-\theta_{ijc}}}{M_{ijc}!} \qquad (13)$$

Because the heteroskedasticity in a trade flow context might be unobserved, or the variable that appropriately predicts the heteroskedasticity is omitted, Burger et al. (2009) use a negative binomial Poisson. The conditional mean remains the same as the above Poisson model, but the probability function takes on a dispersion parameter that takes the unobserved heteroskedasticity or dispersion into account.

The theory derived above supports the use of a price ratio between organic and conventional goods as a determinant of import demand within a traditional gravity trade model specification. In the following chapter, I discuss the data that I use to test the theory and methods discussed in this chapter.

CHAPTER 3: DATA AND SPECIFICATION MODEL

For this study, unilateral trade flows are taken from the Global Agricultural Trade System of the US Department of Agriculture's Foreign Agricultural Service (USDA FAS). The FAS began measuring import and export data of organic agricultural goods beginning in 2011. The data used in this study include 124 observations of quarterly organic corn (yellow dent), organic wheat (red winter), and organic soybeans (not for seed) imports into the United States, measured in thousands of current US dollars. The import values represent the amount paid for the goods, excluding cost, insurance, tariffs, and other charges. Between January 2011 and December 2013, the FAS recorded that 11 countries exported corn, soy, or wheat to the US. The sample includes 12 quarters starting in January 2011. Approximately 32 percent of values are zeroes (see Table 1).

Not all countries are represented, even in zeroes, for all twelve quarters. Where FAS data on organic trade flows does not list an explicit zero observation, I do not assume that the data exists for a particular trading partner, crop, and time period.

For national incomes, I use quarterly GDP data for the United States (the importing country) from the US Bureau of Economic Analysis, monthly GDP data from Statistics Canada, and International Monetary Fund (IMF) and the Organization for Economic Co-operation and Development (OECD) annual GDP statistics for the remaining countries in my sample. All GDP figures are converted to trillions of current US dollars. See Appendix A for a list of countries and other properties of the dataset. Data sources can be found in Appendix B.

The trade volume data are aggregated from monthly to quarterly data because, more often than not, inflows do not occur every month. Therefore, quarterly data better represent a constant stream of trade flows.

Table 1: Summary Statistics

Variable	Obs	Mean	St. Dev	Min	Max
Exporter GDP (trillions US $)	124	1.65	2.27	0.06	8.94
Importer GDP (trillions US $)	124	16.33	0.62	14.82	17.10
Exporter Population (millions)	124	286.03	497.76	3.40	1357.24
Importer Population (millions)	124	314.59	1.80	311.59	316.23
Distance between capital cities (km)	124	7137.62	3837.288	548.3946	11761.81
Quarterly Import Value (thousands US $)	124	2571.85	4255.08	0	20474
Number of quarters where previous quarter had positive imports	124	0.63	0.49	0	1
Binary equivalence agreement	124	0.32	0.47	0	1
Latent Variable (1 if positive imports, zero otherwise)	124	0.68	0.47	0	1
Corn	124	0.13	0.34	0	1
Soy	124	0.68	0.47	0	1
Wheat	124	0.19	0.40	0	1

Of the total sample, 84 observations are imports of soy, 24 of wheat, and 16 of corn[1]. Total imports of wheat and soy tend to be stable and generally increasing over time over the study period, while organic corn imports spiked from zero to millions of dollars in the 3rd quarter of 2013 (see Figure 5). There has been increasing demand for organic corn as a feed input for organic poultry and dairy products. This, in combination with the drought in the US during the summer of 2013, is likely to be the cause of the observed jump in organic corn imports. Because the spike in corn imports is an unusual occurrence, I present the estimation results without the third quarter of 2013 for corn.

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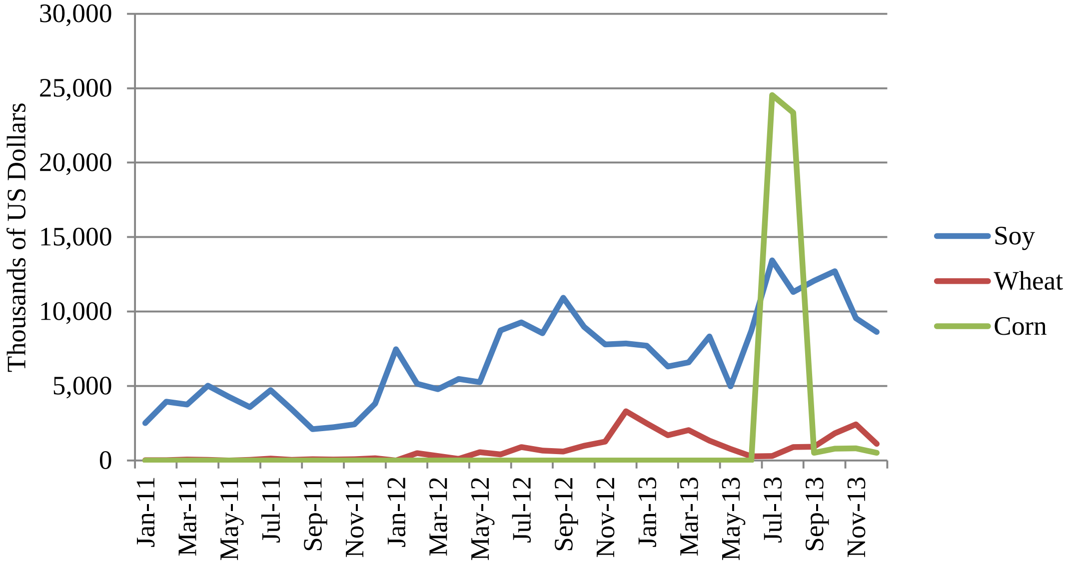
[1] The USDA FAS does not currently collect organic corn, soy, and wheat export data from the United States, so this study specifically estimates import data for these crops. However, it is highly likely that the United States does, in fact, export organic grains and soybeans.

Figure 5: Monthly Organic US Imports (thousands US $) by Crop, 2011-3



Source: USDA FAS Global Agricultural Trade System, 2014.

The World Bank is the source for annual estimates of population size. Where 2013 population and GDP estimates from the World Bank are not available, I extrapolate by averaging growth from the past 3 years. The natural resistance to trade is proxied by a combination of simple great circle distance in kilometers between economic centers of each trading pair of countries from Centre d'Etudes Prospectives et d'Informations Internationales (CEPII), and a binary variable representing the presence or lack of an organic equivalence agreement. The USDA Agricultural Marketing Service website presents information on current equivalence agreements between the US and other trading partners. Equivalence agreements reduce transaction costs, and therefore natural trade resistance. As noted earlier, these agreements allow agricultural goods certified as organic to USDA standards by foreign accrediting agencies to be recognized as organic when imported into the United States, or conversely for organic products exported from the US.

Due to the size of the data set, however, there are not enough instances of equivalency agreements for the current sample to be certain the binary variable strictly represents the effect of these agreements. The only countries in the data set with equivalence agreements with the United States over the sample time period are Canada, Romania, and the Netherlands. The equivalence agreement binary is therefore problematic for this study's estimation, but can be more useful as the data set is expanded in future years and if organic exports from the United States is included.

The US domestic price ratio between organic and conventional wheat, corn, and soybeans is taken from the Mercaris Data Company, which monitors organic and conventional futures and spot prices of the three afore-mentioned commodities, starting in 2007. The prices are reported in dollars per bushel, but were converted to thousands of dollars per metric ton, to match the USDA FAS data. For the length of the sample, organic price premiums were generally increasing for all three crops of interest (see Figure 6)[2]. While the variety of corn (yellow dent) matches between the FAS and Mercaris price data and soybean variety, other than not for seed, is not identified, wheat data for the FAS are for durum wheat, while the Mercaris data recorded red winter wheat prices. The proxy of red winter wheat prices is appropriate as long as the assumption that wheat variety prices move together. According to Mercaris data for 2013, the prices of four varieties of wheat tend to stay within a small range of each other.

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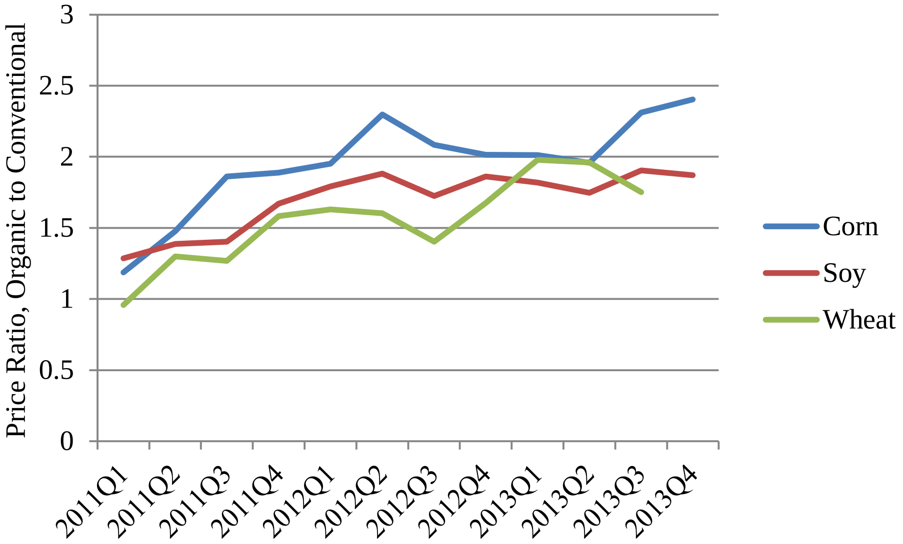
[2] Price ratios for these crops were unusually low, by historical standards, at the beginning of the sample period.

Figure 6: Organic to conventional price ratios by crop in the US, 2011-2013



Source: Mercaris Data Company, 2014.[3]

In studies with a focus on a particular region, the sample is unbalanced because not all countries in the world are represented. This is also the case with the dataset used in this study. Between 2011 and 2013, the FAS only recorded imports of wheat, soy, or corn from 11 countries into the United States. Some countries export more than one of the three commodities, so they are represented more than once for one time period. Zero-value observations for a country pair are only included if the country exported that particular crop in at least one quarter in the same year. Carrere (2006) also faces an unbalanced dataset, and includes selection rule terms into the specification model, which are the number of time periods the country pair exists in the sample, and two binary variables. One indicates whether the country pair has values for the entire period and the other is equal to 1 if the country pair observation was present in the previous time period. Because only one country pair (Canada) traded for all quarters in soy and wheat, and the

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[3] Note: At the time of this study, there were no data available in this data series for the conventional vs organic prices for wheat in the fourth quarter of 2013, so for the analysis, the organic price for wheat was taken from a data project from the same source and divided by the value of conventional wheat in the same quarter in 2012.

coefficient was insignificant, I do not include the former binary variable in my specification. I also exclude the control for number of quarters traded because it adds unnecessary endogeneity to the model.

Unlike previous gravity trade models, my sample includes only one importing country, the United States. Naturally, there is little variation in national income and population over the narrow time frame of available import data. In the next chapter, I show that these variables are not appropriate to include in the estimation for this particular sample. However, I include importer income and population in the general specification for the purposes of future research with a more balanced data set.

The gravity trade literature employs three distinct estimation procedures. The first is the traditional log-normal OLS specification, from the model I derived in the previous chapter. Trade volume is a multiplicative function of the explanatory variables. The value of trade flows is log-transformed to achieve a linear model, which takes the form of the following equation for each time period:

$$\ln M_{ijc} = \beta_0 + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln N_i + \beta_4 \ln N_j + \beta_5 \ln D_{ij} + \beta_6 Eq_{ij} + \beta_7 \ln P_{ic} + \beta_8 B_{ijc} + \ln \varepsilon_{ijc} \qquad (15)$$

where M_{ijc} represents the trade volume for crop c, to importer i from exporter j, Y_i (N_i) and Y_j (N_j) are the national incomes (populations) of the importer and exporter, respectively, D_{ij} is the distance in kilometers between the economic centers of the country pair, Eq_{ij} is the binary variable to indicate an equivalence agreement between i and j, P_{ic} is the organic to conventional price ratio in the importing country for crop c, B_{ijc} is the binary variable for trade in the previous quarter between the country-pair in the same crop, and ε_{ijc} is the random disturbance term.

The second estimation approach, as I described above, is the Poisson model, which I use to avoid truncating the dataset by eliminating zeroes. The Poisson model is also used to avoid biasing coefficients when zeroes are included by adding an arbitrary and small constant to all trade volume values in a log-normal model. The functional form, as described in the previous chapter, is Equation 16:

$$\Pr[M_{ijc}] = \frac{{\theta_{ijc}}^{M_{ijc}} e^{-\theta_{ijc}}}{M_{ijc}!} \tag{16}$$

where θ represents the expected value of trade volumes between country *i* and *j* in crop *c* conditional on the vector of explanatory variables.

$$\theta_{ijc} = E[M_{ijc} \mid X] = e^{\alpha + \beta' X_{ijc}} \tag{17}$$

The vector of explanatory variables in the Poisson model is identical to the vector in the above log-normal model. The explanatory variables are still log-transformed due to the multiplicative nature of the gravity trade model, but trade volumes are not log-transformed.

Lastly, previous studies use the Heckman selection model as an alternative method for addressing the problem of zero-level trade flows. The selection model is a probit, where the dependent variable is the latent variable Z_{ijc} , which takes the value of 1 when there is positive trade and zero otherwise. The existence of an equivalence agreement is expected to have a positive relationship with the propensity to select into trade. Ideally, equivalence agreements reduce trade resistance and encourage trade. However, the endogeneity inherent in trade agreements arises because countries that already tend to trade together in organics are more likely to benefit from such agreements. Second, the latent variable Z_{ijc} could also be related to some measure of organic production in a particular country. Organic agriculture is still a niche market, and the origin of imports might heavily depend on which country has an adequate supply for domestic demand, as is the case in the United States.

A natural choice to proxy for organic supply is the certified organic acreage in each exporting country. However, the data available for certified organic acreage by country, from the Research Institute for Organic Agriculture, are for the years 2005 to 2011, which lies outside of this study's time period. Moreover, there are too few countries in the data to certain that the equivalence agreement binary truly represents the effect of the trade agreement. These data issues preclude use of the Heckman specification in this study.

The high number of zeroes in the sample also suggests that log-normal OLS regression is also problematic. Because of multiple data constraints, the Poisson model appears to be the most appropriate model. In the next chapter, I estimate a series of Poisson specifications and discuss the results.

CHAPTER 4: ESTIMATION RESULTS

In this chapter, I present and interpret the results of four nested Poisson specifications with crop fixed effects and a binary variable for trade in a previous quarter (Table 2). I first estimate a traditional gravity trade model and a full model with an equivalence agreement binary variable and the organic to conventional price ratio. Using a likelihood ratio test, I determine that importing income and population variables do not add explanatory power to the model, and remove these terms in models 3 and 4. As discussed in the previous chapter, the only importing country in the sample is the United States, so there is little variation in importer national income and population. A likelihood ratio test for the equivalence agreement for model 3 is unable to reject the null hypothesis that the simpler model, model 4, is more appropriate. All models are estimated with heterskedasticity-robust standard errors.

Across models, the coefficients for exporter income and population are of the expected sign and significant, except for exporter population in models 3 and 4. Most GTM studies find national income elasticities between zero and one, or just above one (Bergstrand 1985, Bergstrand 1989, Eichengreen and Irwin 1998, Carrere et al. 2006). This study finds and elasticity for exporter income of 0.34 to 0.38, which is consistent with the literature. Though exporter income has a theoretically ambiguous effect on the trade of a good, the results of this study suggest that as a country’s total income increases, it is more likely to export organic commodities.

As expected, the estimated coefficients for importer income and population are not statistically different from zero in models 1 and 2. However, the point estimates are positive, which is consistent with theory.

Table 2: Poisson Regression Results

	Model			
	1	2	3	4
Exporter Income	0.34*	0.36*	0.38*	0.37*
	(1.87)	(1.90)	(1.91)	(1.86)
Importer Income	8.44	3.36	--	--
	(1.16)	(0.40)		
Exporter Population	0.34*	0.33*	0.31	0.31
	(1.84)	(1.73)	(1.57)	(1.61)
Importer Population	5.95	11.85	--	--
	(0.16)	(0.30)		
Distance	-0.59***	-0.47**	-0.44**	-0.56***
	(-3.33)	(-2.29)	(-2.15)	(-3.19)
Price Ratio	--	1.63	2.95***	2.96***
		(1.35)	(2.71)	(2.73)
Equivalence Agreement	--	0.34	0.37	--
		(0.61)	(0.67)	
Corn Binary	-1.20	-1.43*	-1.53**	-1.53**
	(-1.54)	(-1.84)	(-2.02)	(-2.01)
Soy Binary	1.17***	1.14***	1.11***	1.12***
	(4.17)	(4.25)	(4.44)	(4.48)
Previous Quarter Binary	1.45***	1.47***	1.50***	1.51***
	(3.36)	(3.40)	(3.49)	(3.59)
Constant	-49.23	-70.93	5.71***	6.82***
	(-0.24)	(-0.35)	(3.50)	(5.69)
Observations	120	120	120	120
Pseudo -R2	0.689	0.694	0.689	0.688

Dependent variable is the quarterly value of imports in thousands of current US dollars.
Values in parentheses are *z*-statistics.
The reference group for the corn and soy binary variables is wheat.
$p<0.10$ *, $p<0.05$ **, $p<0.01$ ***

The Poisson estimation provides strong evidence that organic imports are negatively associated with distance. The negative and significant coefficient estimates supports the theory of transport costs causing a natural resistance to trade. The estimated elasticities for distance range from -0.44 to -0.56, which are also comparable to previous studies using Poisson estimation (Silva and Tenreyro 2006, Burger et al. 2009).

The previous quarter binary variable is found to have a positive and significant effect on imports for all models, which is consistent with the findings of Carrere et al. (2006). A positive coefficient for this binary variable indicates that uninterrupted trade flows are likely to be larger in value. The crop fixed effects are generally significant and of the expected sign for all models in Table 2. Compared to wheat, very small values of corn were imported into the US over the study period outside of the third quarter of 2013. Soy imports into the US were more stable over time and of a higher value than the amount of wheat imported into the US between 2011 and 2013, so a positive point estimate for soy and negative point estimate for corn is expected.

The estimation results for the organic to conventional price ratio in models 2 through 4 provide evidence for the theoretical findings discussed in Chapter 2. The estimated coefficient for the price ratio is only significant once the importer income and population are removed from the model. However, the point estimates are positive in each of the three specifications. The elasticities from models 3 and 4 indicate that imports increase by approximately three percent when the price ratio in the United States increases by one percent.

A positive result for the price ratio elasticity suggests two possible, and slightly related, interpretations. First, as demand grows for organic commodities and exerts upward pressure on price, consumers look to foreign sources that are relatively cheaper, even after considering some level of risk into the lower price. Second, because organic production is highly inelastic (there is generally a 3 year waiting period to absolve land of banned chemicals), the higher prices indicate a domestic shortage of organic goods, and distributors have no choice but to import grains to meet demand.

The Poisson specification suggests that domestic organic price premia can appropriately proxy restricted domestic supply because the estimated effect is positive and significant.

While this study successfully reaches the research objective for estimating an effect of the organic to conventional price ratio, the data issues related to an equivalence agreement preclude strong evidence of an effect of equivalence agreements on organic imports into the United States. In models 2 and 3, the equivalence agreement binary variable seems to have no effect on organic imports, and a likelihood ratio test indicates that it should be dropped from the model.

To provide evidence that the circumstance of the drought in 2013 does not singularly determine the results of the Poisson estimation, I exclude the observations of corn imports for the third quarter of 2013 for models 1 through 4. Individually, the trade import values are not particularly extreme to be considered outliers, but jointly the four observations represent larger quarterly volume than the rest of the sample in any crop. I present the estimation results including the full sample in Table 3.

Most coefficients increase in magnitude relative to the results in Table 2, but two insignificant coefficients (importer population and equivalence agreement binary variable) become negative, yet are still insignificant. Exporter population is now not significant in any model. The pseudo R^2 are noticeably smaller in the full sample models because the patterns that explain soy and wheat imports well in the previous model cannot as easily explain the sudden demand for corn.

Table 3: Poisson Regression Results, Full Sample

	Model - Poisson			
	5	6	7	8
Exporter Income	0.36*	0.35*	0.35*	0.38**
	(1.93)	(1.71)	(1.77)	(1.98)
Importer Income	12.75	2.15	--	--
	(1.61)	(0.24)		
Exporter Population	0.32	0.31	0.31	0.29
	(1.64)	(1.61)	(1.64)	(1.48)
Importer Population	-21.09	-5.09	--	
	(-0.52)	(-0.13)		
Distance	-0.52**	-0.64***	-0.63***	-0.49**
	(-2.48)	(-3.17)	(-3.21)	(-2.42)
Price Ratio	--	3.27**	3.66***	3.64***
		(2.21)	(2.83)	(2.83)
Equivalence Agreement	--	-0.42	-0.41	--
		(-0.68)	(-0.67)	
Corn Binary	1.23**	0.78	0.74	0.72
	(2.26)	(1.49)	(1.34)	(1.33)
Soy Binary	1.07***	1.05***	1.05***	1.04***
	(3.60)	(3.99)	(4.07)	(4.00)
Previous Quarter Binary	0.37	0.50	0.51	0.49
	(1.02)	(1.42)	(1.42)	(1.38)
Constant	94.92	31.80	8.27***	7.03***
	(0.45)	(0.15)	(4.67)	(4.91)
Observations	124	124	124	124
Pseudo –R^2	0.4771	0.495	0.495	0.494

Dependent variable is the quarterly value of imports in thousands of current US dollars.
Values in parentheses are *z*-statistics.
The reference group for the corn and soy binary variables is wheat.
p<0.10 *, p<0.05 **, p<0.01 ***

With the exception of the insignificant effect of equivalence agreements on imports, the results of the Poisson model are consistent with theory, and the point estimates are generally stable across models. This study indicates that the Poisson specification is the most appropriate approach for future research using the FAS organic trade data. For comparison, I present estimation results using log-normal OLS in Appendix D.

CHAPTER 5: CONCLUSIONS

5.1 Implications

The relentless growth of organic food sales in the US, and the increasing dependence on imports to fill the gap between domestic supply and consumer demand warrant econometric analysis. Organic agriculture is transitioning into mainstream, and the gravity trade model has not yet been applied to understand patterns of trade. That is where this study makes a significant contribution to the literature.

This study estimates a gravity trade model using quarterly data from the Foreign Agricultural Service of the USDA for organic corn, soy, and wheat imports into the United States from 11 countries between 2011 and 2013. I add two additional variables of interest relevant to the organic foods market: the existence of an equivalence agreement between the exporting and importing country and the ratio between organic and conventional domestic prices for each crop (also known as the organic price premium). All models are estimated with a binary variable to control for an unbalanced sample, using the example of Carrere (2006). The variable equals one if the country pair traded in a particular crop in the previous quarter and zero otherwise.

Due to a large number of zero value observations, common to all gravity trade model studies, I employ a Poisson model, as Silva and Tenreyro (2006) and Burger et al. (2009), instead of the traditional log-normal OLS specification of most other trade model studies. Econometric results are presented without abnormally large observed imports of corn in the third quarter of 2013, when a severe drought affected organic feed corn in the US.

Generally, the results from the basic trade model indicate that exporter population and income have positive and significant effects on trade, though the addition of the variables of interest reduces the significance of exporter population. The estimated coefficients for importer income and population are not statistically different from zero. This result is understandable given that there is only one importing country, the United States, in this sample. Across models, the price premium term is significant and positive, which indicates strong evidence that the organic market and imports are driven by restricted domestic supply and mounting consumer demand. Across all models, distance between trading partners negatively affects the value of imports, which supports the theory that transport costs increase with distance.

There is no evidence from the Poisson estimation that equivalence agreements affect organic imports into the United States. With the limitations of the FAS trade data currently available, it is not possible to separate the effect of an equivalence agreement from other properties of Canada and the two EU countries in the sample that affect organic trade with the US. If the FAS begins collecting export data on corn, soy, and wheat, a statistically significant effect might emerge in future studies.

Of the three research objectives outlined in chapter one, this study successfully meets two. First, I assembled a dataset that includes quarterly import values for organic wheat, soy, and corn, total quarterly GDP for the US and the exporting country, annual population, distance in kilometers between economic centers, a binary variable for equivalence agreement and a binary variable for positive trade in a crop in the previous quarter with the same trading partner, and the organic to conventional price ratio for each crop. The dataset also includes the natural log transformation of the explanatory variables.

Second, I estimate a basic gravity trade model using a Poisson specification and find results that are consistent with theory and the gravity trade model literature. Finally, I introduce a binary variable to estimate the effect of an equivalence agreement on imports and the organic to conventional price ratio. The estimation results provide evidence that as domestic prices for organic wheat, corn, or soy rise relative to the conventional substitute, the US increases imports. However, this study is not successful in estimating a reliable effect associated with the existence of an equivalence agreement organic imports from that trading partner.

5.2 Limitations

A typical gravity trade model study uses a dataset with multiple importers and multiple exporters. Unfortunately, the FAS does not yet collect wheat, corn, or soy exports from the United States. So, the importing country income and population in the dataset for this study is exclusively the US. The lack of observed heterogeneity limits the predictive power and consistency of the estimated coefficients for importer income and population. Because of this limitation, I omit importing income and population variables from the last two models in the results section.

The FAS dataset is also limited in that it is a new dataset representing a market with relatively little data yet collected. It appears that data were not collected for all organic products during the time frame that this study uses (2011-2013). When import observations are omitted, and not explicitly zero, they are not included in this study.

5.3 Future Research

As organic agricultural goods trade data continue to be collected by the Foreign Agricultural Service and as more countries enter the niche market of organics, the opportunities for more research abound. With more data points, this study can be replicated over longer periods of time and with other econometric methods such as panel fixed effects. Other papers could focus on the effects of equivalence agreements using bilateral aggregate trade volume of all organic products monitored by the FAS. Further price ratio research could only be pursued if more organic and conventional prices are recorded consistently over time for other organic goods.

Future research with more observations will be able to improve our understanding of whether the results of this study are indicative of truly unusual properties of organic trade or merely the result of small sample size. With more data, including data for certified organic agricultural land by country over time or trade flows between many country-pairs, a Heckman selection model might be another appropriate estimation strategy, using the example of Bergstrand and Baier (2002) and Da'ar (2011).

This study sets a precedent for how to use FAS's new resource to understand more about the international market for organic agricultural products, and presents original results regarding the effect of the interaction term between a preferential trade arrangement (in this case, an equivalence agreement) and distance.

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APPENDIX A

The following table provides additional information about the trade data used in this study.

		Quarters			Average Import Value	
Country	Crop	Total	Including Zero	Positive Values	Including Zero	Positive Values
Argentina	corn	4	2	2	5320.5	10641
Argentina	soy	12	1	11	120.5	321.3333
Argentina	wheat	8	5	3	1469.833	1603.455
Brazil	corn	4	3	1	3241.5	12966
Canada	corn	4	2	2	3930.5	7861
Canada	soy	12	0	12	2071.75	2071.75
Canada	wheat	12	0	12	6737.25	6737.25
China	soy	12	0	12	7474.667	7474.667
India	soy	12	0	12	3997.083	3997.083
Kazakhstan	soy	8	5	3	188	501.3333
Netherlands	soy	4	3	1	157.5	630
Romania	corn	4	3	1	136.25	545
Romania	soy	8	3	5	374	598.4
Russia	soy	4	3	1	8.75	35
Turkey	soy	8	6	2	46.5	186
Uruguay	soy	4	2	2	110.75	221.5
Uruguay	wheat	4	2	2	111.75	223.5

Source: USDA FAS Global Agricultural Trade System, 2014.

APPENDIX B

The following table presents the sources of data for the dataset constructed for this study.

Data Source	Data	Year Last Updated
USDA FAS Global Agricultural Trade System	Values of Imports of Organic Corn, Soy, and Wheat into the United, in thousands of US dollars	2014
World Bank Databank	Populations, in millions, by country; GDP in trillions of US dollars	2013
International Monetary Fund (IMF)	Annual GDP for selected countries, in trillions of current US dollars	2014
Organization for Economic Co-operation and Development (OECD)	Quarterly GDP for selected countries, in trillions of current US dollars	2014
Centre d'Etudes Prospectives et d'Informations Internationales	Distance in kilometers between economic centers	2011
Mercaris Data Company	Prices of organic and conventional corn, soy, and wheat, in current US dollars per bushel	2014
USDA ERS	US land in certified organic production by crop in acres, 1995-2011	2013
USDA National Organic Program	Documentation on the existence and start dates of equivalence agreements between the United States and other countries.	2014
US Bureau of Economic Analysis	US quarterly GDP	2014
Statistics Canada	Canadian quarterly GDP	2014

APPENDIX C

The following tables provide information about the total estimated organic corn, soy, and wheat cropland in the United States. The first table gives the proportion of annual cropland for each organic crop in the US of total organic annual cropland. The total acreage excludes certified organic pastureland, tree nuts, and fruit orchards.

Percentage of total annual organic cropland in organic corn, soy, and wheat, 1995-2011

	1995	2000	2005	2008	2011
Corn	8.09	8.80	10.74	10.31	12.32
Soy	11.69	15.36	10.04	6.66	6.96
Wheat	29.92	23.31	24.15	22.04	18.11
Subtotal	49.69	47.47	44.93	39.01	37.39

Source: USDA ERS (2013)

Total acreages in annual organic crop production in the US by corn, soy, and wheat, 1995-2011

	1995	2000	2005	2008	2011
Corn	32650	77912.24	130672.1	194637	234470
Soy	47200	136071	122217.3	125621	132411
Wheat	120800	206473.6	293824	415902	344644
Total Organic Cropland	403800	885656	1216718	1887105	1902812

Source: USDA ERS (2013)

APPENDIX D

The following table presents estimation results when fitting this study's sample data to a traditional log-normal OLS specification for comparison with the Poisson results in Chapter 4. These results are shown with both truncated and full sample, but all the specifications below do not include the four unusual observations for corn in the third quarter of 2013. The arbitrary constant added to all import values below is 1. Compared to the Poisson, the OLS estimation results are inconsistent and problematic.

	Model - OLS					
	Truncated			Including Zeroes		
	9	10	11	12	13	14
Exporter Income	0.10	0.05	0.09	-0.44	0.02	-0.29
	(0.27)	(0.13)	(0.26)	(-0.82)	(0.05)	(-0.54)
Importer Income	19.19**	6.62	--	23.01*	6.34	--
	(2.16)	(0.65)		(1.69)	(0.36)	
Exporter Population	0.39	0.42*	0.37	1.24***	0.93**	1.11***
	(1.65)	(1.69)	(1.53)	(3.02)	(2.43)	(2.66)
Importer Population	-7.48	-3.40	--	3.99	17.66	--
	(-0.14)	(-0.06)		(0.04)	(0.17)	
Distance	-0.69***	-0.80***	-0.70***	-1.58***	-0.81*	-1.49***
	(-3.49)	(-2.69)	(-3.55)	(-4.25)	(-1.73)	(-4.06)
Price Ratio	--	3.95***	5.41***	--	4.38	6.49***
		(3.10)	(5.88)		(1.54)	(4.57)
Equivalence Agreement	--	-0.22	--	--	1.64*	--
		(-0.42)			(1.83)	
Corn Binary	0.28	-0.46	-0.63	-3.30***	-4.28***	-4.09***
	(0.33)	(-0.55)	(-0.75)	(-3.03)	(-3.48)	(-4.01)
Soy Binary	1.20***	1.16***	1.11***	1.09*	0.80	0.85
	(3.54)	(3.53)	(3.75)	(1.75)	(1.22)	(1.40)
Previous Quarter Binary	0.63	0.71	0.75	1.90***	1.99***	2.06***
	(1.10)	(1.22)	(1.41)	(2.98)	(3.17)	(3.25)
Constant	-0.90	9.53	6.85***	-75.99	-115.96	7.52***
	(0.00)	(0.03)	(6.09)	(-0.14)	(-0.21)	(4.11)
Observations	80	80	80	120	120	120
Adjusted R^2	0.554	0.583	0.577	0.546	0.562	0.546

Dependent variable is the log of quarterly value of imports in thousands of current US dollars.
Values in parentheses are *t*-statistics.
The reference group for the corn and soy binary variables is wheat.
$p<0.10$ *, $p<0.05$ **, $p<0.01$ ***