Three Essays on International Trade

by

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Abstract

This dissertation is composed of three essays. The first essay assesses the impact of agricultural support policies on refined sugar exports. A theoretically consistent gravity model is extended to include the spatial dependence across trade flows. The proposed methodology takes into account spatial effects since it is based on the concept of location. The study provides evidence of the distorting effects of market price support on exports of refined sugar.

The second essay uses balance panel data for 156 countries from 2006 to 2008 to investigate how trade facilitation, defined as reducing time delays at borders affects trade. I estimate a Heckman sample selection model, and find that a 10% reduction in relative delays is associated with an increase of 8% in the volume of trade. Additionally, the simulations results show that improved trade facilitation would be beneficial for all countries but especially for developing countries.

The third essay develops a spatial panel simultaneous equation model to first investigate the relationship between foreign direct investment and trade, and second to assess the presence of complex foreign direct investment of multinational firms using 24 OECD countries from 1999-2009. The empirical results indicate a complementary relationship between foreign direct investment and trade, as well as the presence of complex foreign direct investment with agglomeration economies.

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Introduction

Agriculture has faced the most severe protectionism due to government intervention through domestic support and export subsidies for the sole purpose of transferring income to farmers. As noted by Johnson (1991) these domestic programs create unwanted production and increase income disparity within agriculture. In addition to domestic support, many countries protect their agricultural markets through border protection by imposing tariffs and import quotas. These instruments depress world prices and increase local prices that benefit farmers, making the agricultural sector highly regulated and subsidized. This inherently leads to a distortion of agricultural trade. As an example, Anderson et al. (2001) showed that domestic support and border protection reduce agricultural growth rate which is much slower than that of manufactured goods. As a result, agricultural trade policies and trade barriers have become one of the contentious issues facing the World Trade Organization (WTO).

The challenge faced by policymakers is to identify which domestic support has the biggest effect on agricultural trade. This challenge has inspired my desire to analyze the impact of the market price support on refined sugar. An analysis of the topic requires the application of spatial econometrics in order to assess the connectivity between market conditions of two regions. As stated by Tobler's (1979, p 8) *first law of geography* "everything is related to everything else, but near things are more related than distant things."

In spite of the slow growth of agricultural trade, the volume of world merchandise trade rose by 14 percent from 2007 to 2010 (WTO, 2010). One possible explanation for the increase of international trade is a reduction of tariffs and nontariff barriers, as well as the decline in transportation costs. A second possible explanation is the advancement of communication technologies and improvement in infrastructure as a consequence of decreasing communication and transport costs for differentiated goods (Tang, 2006). Nevertheless, Wilson, Mann, and Otsuki (2003) argue that transaction costs associated with the movement of goods across borders reduce international trade.

In a competitive environment, a cross border investment, known as foreign direct investment (FDI) can be undertaken by profitable firms or multinational corporations (MNCs) to establish affiliates in foreign markets and serve other markets through exports. MNCs have two motives, the market access motive or the comparative advantage motive, which are called horizontal FDI and vertical FDI. Horizontal FDI consists of MNC that have facilities producing the final goods in several countries. Such investments are likely to occur between similar countries. Vertical FDI by MNCs is the geographical fragmentation of the production into stages on the basis of factor intensities, skilled–labor- intensive, and skill–labor-abundant (Markusen, 2002).

Previous work in theses area used the gravity model that explains bilateral trade and between two countries as a function of their incomes (GDPs) and the distance between them. However, the gravity model does not take into account the role of location to explain the complexity of economic behavior in space. The purpose of this dissertation is to provide a comprehensive economic analysis to examine three different areas of international trade. It demonstrates how to incorporate the notion of relative space or location emphasizing the effect of distance into the gravity model to understand how economic agents within a region may affect its neighbors which is known as spatial effects.

This dissertation consists of three chapters. The first chapter examines the evidence of the distorting effects of domestic support, specifically the market price support for raw sugar on trade of refined sugar. A spatial regression analysis that incorporates spatial dependence is compared with the theoretically-consistent gravity model. Spatial dependence is important in explaining the interdependence across trade flows, while the theoretically-consistent gravity model controls for omitted variables and endogenous policy variables. The results of this study indicate the potential benefit in the reduction of the market price support, in particular OECD countries where market price support is an important tool to protect their producers (Matthews, 2008).

The second chapter analyzes how trade facilitation, defined as reducing transactions costs associated with the movement of goods across borders affect trade. A Heckman sample selection model is applied to allow a complete decomposition of the volume of trade into the intensive and extensive margins to investigate time as a trade impediment. The results indicate that a 10% reduction in relative delays is associated with an increase of 8% in the volume of trade, suggesting that more efficient customs regulations would increase trade.

The last chapter investigates the relationship between FDI and exports, specifically whether FDI and exports are complements or substitutes applying a generalized spatial two stage least squares (GS2SLS) model developed by Kelejian and Prucha (2004) extended to a simultaneous spatial panel data. The results provide empirical evidence of complementary between FDI and trade, as well as the presence of complex FDI with agglomeration economies.

The results from these studies will be useful for researchers and policymakers in designing and implementing appropriate measures to increase international trade. As an example, Chapter 1 results can be used to inform policymakers to encourage the debate at the

WTO that emphasizes reduction of the domestic support provided to agriculture through the market price support. The results from Chapter 2 can be used to stimulate governments of the need to improve their administrative procedures, improve physical infrastructure, and have a network of communications in order to reduce the time required to export or import a good to other markets. The results from Chapter 3 opens a door for future research on FDI to better understand the complex strategies of MNCs in an interdependent world.

Chapter 1: Agricultural Policies and Refined Sugar Exports: A Theoretically Consistent Gravity Model with Spatial Econometrics

1. Introduction

Sugar is an important agricultural crop in the world market with a total production of 160 million tons raw value, consumption of 159 million tons, and exports 51 million tons in 2009 (USDA, 2010). Sugar is produced in more than 100 countries, and is one of the heavily regulated commodities, particularly in OECD countries with the worst offenders the European Union (EU), the United States (US), and Japan through domestic support, export subsidies, and import quotas for the purpose of transferring income to farmers (Elobeid and Beghin 2006). For example, Japan protects its sugar market through a mix of producer price support and tariffs on imports. The US tools are the loan program and import restrictions. The EU uses import restrictions, limited market access, and subsidization of exports to protect its sugar producers. While such policies achieve their goal of protecting producers, they have large effects on world sugar markets by (1) depressing the world price, (2) increasing world price variability, and (3) reducing the volume of international trade.

The present study examines the evidence of the distorting effects of domestic support, specifically the market price support on trade of refined sugar. A spatial regression analysis that incorporates spatial dependence is compared with the theoretically-consistent gravity model. Spatial dependence is important in explaining the interdependence across trade flows, and produces more consistent estimates than the theoretically-consistent gravity model even though controlling for omitted variables and endogenous policy variables. The results of this study indicate the potential benefit in the reduction of the market price support, in particular OECD countries where market price support is an important tool to protect their producers (Matthews, 2008).

The rest of the paper is organized as follows. Section II provides an overview of agricultural support, followed by an analysis of the market price support. The review of literature is examined in Section III. Section IV introduces both the theory and empirical specification of the gravity model and the spatial econometrics. Section V presents the data set and empirical results, and Section VI concludes.

2.1. Overview of Agricultural Support

In 1994, the Uruguay Round Agreement on Agriculture (URAA) under the General Agreement on Tariffs and Trade (GATT) mandated its members to reduce domestic support and export subsidies, and to facilitate market access to lessen distortion in the world sugar market and to increase export opportunities for more efficient producers. The URRA classified these policies in three "boxes" according to their impact on international trade. Those policies deemed to have the least distorting trade effect are placed in the " green" box and are exempt from reduction; those policies that aggregate programs measured by the aggregate measure of support (AMS) judged to be trade distorting are placed in the "amber" box and are subject to reduction; finally the " blue" box refers to policies that provide support programs intended to limit production and are not included in the AMS, making them exempt from reduction.

The AMS is based on the Producer Support Estimate (PSE) primarily used by the Organization for Economic Cooperation and Development (OECD) countries to monitor and evaluate agricultural policies by country and specific commodity. As mentioned by Legg (2003), the PSE is defined since 1990 as “an indicator of the annual monetary value of gross transfers from consumers and taxpayers to agricultural producers, measured at the farm level, arising from policy measures that support agriculture, regardless of their nature, objectives or impacts on farm production or income. The PSE includes market price support, payments based on output, payments based on input used, and payments based on historical entitlements (OECD 2001).

According to Oskam and Meester (2006), the major agricultural support in OECD countries is the market price support. It is defined as the annual monetary value of gross transfers from consumers and taxpayers to agricultural producers arising from policy measures that create a gap between domestic market and border prices of the specific agricultural commodity measured at the farm gate level (OECD 2001; Legg 2003). According to OECD (2010), the market price support is based on the market price differential (MPD) which is the difference of the domestic market price and the border price for a specific commodity.

> The benefit of calculating the value of price support transfers through an MPD is that it captures in a single measure the combined impact on market prices of a potentially complete set of price policies. Policies which raise the price received by producers for a commodity without changing the market price (i.e. without raising consumer prices) are included elsewhere within the PSE under category A.2 Payments based on output (OECD p. 59).

The market price support represents the price differential between the domestic price and the world reference price for the same commodity, a positive sign of the price gap implies the market price support per unit of product, while a negative sign of the price gap suggests a tax on agriculture that benefit consumers (Matthews,2008).

2.2. Analysis of market price support

Given that market price support to farmers increases both domestic producer and consumer prices, a relevant question is what would be the effect of the market price on trade for refined sugar. This point is illustrated in Figure 1a, 1b and 1c which show an analysis of the market price support for an exporting large country.

Figure 1(a) depicts the raw sugar market with supply (S), demand (D), and the price of raw sugar (Pr*). Figure 1(b) is the market for refined sugar with supply (Sd), demand (Dd), and price (Pd). Figure 1(c) represents the international market with excess supply schedule (ES), world excess demand (Dw), and the world price (Pw). In this analysis, I assume that Pd* and Pw* are equal in order to evaluate how an increase in the market price support affects all markets.

Consider the absence of market price support. In the raw sugar market, production is Q and price Pr*. In the refined sugar market, the country produces S* and consumes D* at price Pd, and exports the surplus equal to X* in the international market at price Pd* = Pw*.

If there is government intervention in agriculture through market price support, domestic producers increase production of raw sugar from Q to Q', while the price rises from Pr* to Pr'. The high price raw sugar is transmitted to the refining sugar industries by increasing their production costs. This is seen by the leftward shift of the refined sugar supply schedule from Sd to Sd' increasing the price from Pd* to Pd'. As a result, the country's production of refined sugar decreases from S* to S' associated with the reduction of domestic consumption from D* to D'. As the refined sugar supply schedule shifts leftward, the excess supply curve also shifts leftward from ES to ES' in the international market. As a result, exports of refined sugar fall from X* to X' and the world price increases from Pw* to Pw'. There is a distortion in the country's volume of trade due to an increase in the market price support in the form of lower exports and higher domestic price as well as higher world price.

3. Literature Review

The literature reviewed in this section is twofold. First, I review studies that investigate the impact of agricultural support on welfare (Gemmill, 1977; Boyd, Doroodian and Power, 1996; Tobarik, 2005). Second are studies that investigate the effects of agricultural support on the sugar market with emphasis on world sugar price (Gemmill, 1977; Koo, 2002; Elobeid and Beghin, 2006).

Gemmill (1977) employed a spatial equilibrium model to evaluate the effects of the sugar program in the US, and found a welfare gain of $33 million in the US under free trade. Leu, Schmitz and Knutson (1987) also found that the US would have a net social benefit of $1,888 million a year under free trade. Boyd, Doroodian and Power (1996) analyzed the removal effects of the US sugar import quota system in a general equilibrium framework. They showed that removing the US sugar quota import generates a net economic benefit estimated at $ 254,000 annually, and Borrell and Pearce (1999) argued that if the major sugar producers liberalize trade, this would generate a global welfare gain of $ 6.3 billion a year.

More recently, Van der Mensbrugghe, Beghin and Mitchell (2003) used the global computable general equilibrium linkage model to evaluate the effects of the tariff rate quota (TRQ) in sugar markets in the US, the EU and Japan, as well as multilateral trade liberalization by other countries. Their results suggest that full multilateral trade liberalization engender global welfare gain of about $3 billion. Tokarik (2005) investigated the removal of agricultural support in sugar markets in OECD countries using both partial and general equilibrium models. He found that multilateral liberalization would result in an increase in welfare by over $2 billion in the EU and by $166 million in the US.

Gemmill (1977) examined the effects of US sugar program on the US domestic sugar and world sugar prices. He provided evidence that the world sugar price would increase by 32% and the US domestic sugar price would decrease by 9% if the sugar program had been eliminated. In evaluating the effects of trade liberalization under the Uruguay Round on the world sugar market, Devadoss and Kropf (1996) argued that these provisions will contribute to more stable world sugar price and consumers in countries where there are strong government subsidies and other forms of intervention will enjoy lower domestic sugar price.

Koo (2002) analyzed how agricultural support in the US and EU affect the world sugar price. He applied the global sugar policy simulation developed by Benirschka, Koo, and Loo on 17 sugar- producing and consuming countries. He found that liberalizing the US and EU sugar markets would lead to a 68.2% increase in the world sugar price, and a 4.7% decrease in the US wholesale sugar price

Elobeid and Beghin (2006) examined the effects of domestic support and trade policies on the sugar market in OECD and non-OECD countries within a partial equilibrium framework. Their study showed that the removal of domestic policies and trade distortions would increase the world sugar price by 48%. Additionally, their results indicated that the higher world sugar price induces a lower domestic sugar price on average by 40% and 62% in the EU and Japan respectively, and by 9% on average in the US.

While these studies have examined the impact of various agricultural and trade policies on sugar trade, to the best of my knowledge, none of them has considered the role of spatial relationship across geographically close countries in explaining the incidence of market price support on trade of refined sugar, despite the presence of processing industries that process raw sugar into white sugar. In addition, the application of the spatial econometrics method to trade data is a new area for researchers as opposed to the ordinary least squares (OLS). This study contributes to the literature by applying the spatial econometrics approach on a balance panel data to assess the effect of market price support on trade of refined sugar. Taking into account spatial lag dependence and spatial error autocorrelation are used to evaluate both the spillover effects of the market price support across economies and generates consistent parameter estimates.

4.1. The Theoretical Foundation of the Gravity Model

Tinbergen (1962) was the first to apply the gravity model to analyze international trade flows analogous to Newton's Law of Universal Gravity. The gravity model predicts that bilateral trade flows between two countries is directly related to their economic "masses" measured as GDP and negatively related to the distance between them which is a proxy for transportation costs. Linnemann (1966) added more variables such as population, and put forth a theoretical justification of the gravity model of international trade flows in terms of the 'quasi-Walrasian' equilibrium system that determines total foreign supply and total foreign demand of a country.

However, it was Anderson (1979) that developed the first theoretical foundation for the gravity model based on the properties of the pure expenditure systems that assume products are differentiated by place of origin, which implies that each country is completely specialized in the production of its own good. Since then, several studies including Bergstrand (1990) have contributed to improve the theoretical foundation of the gravity model with trade theories based on models of imperfect competition and with Heckscher-Ohlin. Deardorff (1998) showed that the gravity model can be derived from the Heckscher-Ohlin model both with frictionless trade and with a trade impediment in which the bilateral export volume is influenced not only by the geographical distance between two countries but also by their relative location to all other countries.

Building upon the work of Anderson (1979) and Deardoff (1998), Anderson and Wincoop (2003) refined the theoretical underpinnings of the gravity model to emphasize the importance of the price indices called “multilateral resistance” terms, because they depend on transportation costs. They showed that multilateral resistance terms capture the fact that bilateral trade between two regions depends on the bilateral barrier between them relative to average trade barriers that both regions face with all their trading partners. Ignoring multilateral resistance terms could bias the estimation.

Baier and Bergstrand (2007) argued that the theoretical gravity model developed by Anderson and Wincoop (2003) suffers from an endogeneity problem that arises from unobserved time–invariant heterogeneity in trade flows between country pairs since policy related barriers such as tariffs and domestic policies are likely to generate the formation of regional trade agreements (RTAs). As such, they proposed the theoretically- motivated gravity model using panel data with bilateral pair and country-by-time-fixed effects to control for omitted variables and endogenous policy variables which I apply in the present study.

4.2. Specification of the Gravity Model

The gravity model of bilateral trade explains the volume of trade (X_{ij}) between two countries as a function of their incomes (GDPs) and the distance between them. Sanso, Cuairan and Sanz (1993) found empirical evidence that the log linear form of the gravity model is a fair and ready approximation of the optimal form to analyze bilateral trade flows. Although incomes and distance are important to predict the magnitude of bilateral trade flows, other variables such as dummies may be added to the model to indicate membership to an economic area, protection levels, historical ties and border effects. I also include market price support to represent domestic support for farmers. The gravity model is specified in the natural logarithms as follows:

$$\begin{aligned} \ln x_{ij} = \; & \alpha_0 + \alpha_1 lnGDP_i + \alpha_2 lnGDP_j + \alpha_3 lndist_{ij} + \alpha_4 lang_{ij} + \alpha_5 landl_{ij} \\ & + \alpha_6 cont_{ij} + \alpha_7 lnMPS_i + \alpha_8 lnMPS_j + \alpha_9 NAFTA_{ij} + \alpha_{10} EU_{ij} + \varepsilon_{ij} \qquad (1a) \end{aligned}$$

where subscript i denotes the exporter and j is the importer

The variables are defined as follows: X_{ij} is the dollar value of country i exports to country j, GDP_i and GDP_j are gross domestic products of countries i and j expressed as dollar value. $Dist_{ij}$ is the distance between the economic centers of countries i and j, $lang_{ij}$ is a language dummy variable taking the value of 1 if i and j share a common language and 0 otherwise, $Cont_{ij}$ is a dummy variable assuming the value of 1 if i and j share a land border and 0 otherwise. $Landl_{ij}$ is the number of landlocked countries in the country-pair (0, 1,or 2) as in Rose 2004. EU and NAFTA are dummies variables taking the value of 1 if i and j both belong to the same regional trade agreement and 0 otherwise, MPSi and MPS_j are market price support of the respective countries. The error term ε_{ij} captures any other shocks that may affect bilateral trade and assumes to be normally distributed.

The exporting country's GDP can be interpreted as its production capacity and importing country's GDP can be treated as its purchasing power. In fact, a high level of production in country i increases the availability of goods for exports, while a high income in country j suggests high demand for imports. Therefore, I expect the coefficients of GDPs to be positively related to trade flows.

The distance variable is a proxy for natural resistance to trade which include transport costs, transport time, and economic horizon (Linnemann 1966). As distance increase between countries i and j, transaction costs also increase which reduce trade. It is hypothesized to have a negative effect on trade flows. The common language variable is expected to act as an additional stimulus to trade because trading partner speaks the same language which in turn facilitates trade. Thus, it is expected to have a positive coefficient.

The border variable is expected to increase trade flows because it reduces transport cost between trading partners. Therefore, it should be positively related to trade flows. The landlocked variable is hypothesized to have a negative effect on trade flows because of high transportation costs. The dummy variables for EU and NAFTA are used to capture the effects of regional trade agreements. They are expected to stimulate trade among members' countries. EU and NAFTA are hypothesized to be positively related to trade flows.

The coefficient estimate on the market price support variable need to be interpreted with caution. The market price support is applied on raw sugar; however the bilateral trade data are on exports of refined sugar. The coefficient on the exporter market price support variable is expected to be negative because subsidies given to sugar growers have been reduced which is transmitted to refining sugar industries via low cost of production, thereby increasing exports. The importer market price support variable is hypothesized to be positive, implying that high level of subsidies to sugar growers increase production cost of refining sugar industries that put a break on their abilities to export, hence increasing imports.

By introducing multilateral resistance terms, and imposing unitary GDPs coefficients to yield unbiased estimates in equation (1a) as suggested by Anderson and Wincoop (2003), the theoretically-consistent gravity model is specified as follows:

$$ln\left(\frac{x_{ijt}}{GDP_{it}GDP_{jt}}\right) = \alpha_0 + \alpha_{it} + \alpha_{jt} + \alpha_1 lndist_{ij} + \alpha_2 lang_{ij} + \alpha_3 landl_{ij} + \alpha_4 cont_{ij} + \alpha_5 lnMPS_{it} + \alpha_6 lnMPS_{jt} + \alpha_7 NAFTA_{ij} + \alpha_8 EU_{ij} + \varepsilon_{ijt} \qquad (1b)$$

where the subscript t denotes time; α_{it} is the exporter-by-time fixed effect and α_{jt} is the importer -by –time fixed effect to control for the time varying multilateral resistance terms.

Even though correcting for time varying price terms, Baier and Bergstrand (2007) laid out the theoretically-motivated gravity model which takes the following form:

$$ln\left(\frac{x_{ijt}}{GDP_{it}GDP_{jt}}\right) = \alpha_0 + \alpha_{it} + \alpha_{jt} + \alpha_{ij} + \alpha_1 lnMPS_{it} + \alpha_2 lnMPS_{jt} + \alpha_3 NAFTA_{ij} + \alpha_4 EU_{ij} + \varepsilon_{ijt} \qquad (1c)$$

where α_{it} and α_{jt} are the same as in equation (1b). α_{ij} denotes bilateral fixed effects to account for the variation in distance, language, and common border in the gravity equation. As the result, the final equations have to be estimated using ordinary least squares (OLS), the two-way and three-way fixed effects specification of a panel gravity model.

Extending the gravity model to the concept of location or relative space is particularly useful to account for spatial interaction effects, in other words, spatial dependence across trade flows (LeSage and Pace, 2008).

4.3. Spatial Dependence in the Gravity Model

According to Anselin (1988), data collected from observations located in geographic space should incorporate spatial effects known as spatial dependence and spatial heterogeneity. Spatial dependence is caused by the presence of spill-over effects in two distinct ways. The first is the measurement errors for observations in spatial units, that is the error of one observation in unit i is likely to be related to the error in a neighboring unit j. This is called the spatial autocorrelation or spatial error model (SEM). The second factor that may cause spatial dependence is the structural dependencies across observations on the dependent variable in order to access the processes of social and spatial interaction between spatial units or neighborhood effects known as the spatial autoregressive model (SAR) or spatial lag model which is analogous to the lagged dependent variable model in time series regressions (Anselin, 2009).

The other component of spatial effects is spatial heterogeneity which is less prominent in the spatial econometric literature, and describes the result of spatial processes that involve structural instability of the functional form or varying parameters, and heteroskedasticity as a consequence of omitted variables or other forms of misspecification (Anselin, 1988).

The absence of control of spatial dependence across trade flows in the gravity model violates the Gauss Markov assumptions and provides biased and inconsistent ordinary least squares (OLS) estimates. Therefore, inferences based on OLS estimates may be misleading. These findings support the use of an estimation technique to overcome these problems by using maximum likelihood techniques.

4.4. Specification of the Spatial Panels

This study follows Elhorst (2003, 2010) who reviewed the estimation techniques of panel data models extending to the spatial error autocorrelation and a spatially lagged dependent variable. Using a similar strategy, I will focus only on the spatial fixed effects model, because Elhorst and Freret (2009) showed that the spatial fixed effects capture all space – specific, time – invariant variables whose omission could bias the estimates in cross-sectional data. The spatial fixed effect model can be estimated using equation (1a) by incorporating the spatial specific effect written as:

$$Y_{ij} = X\beta + \mu + \varepsilon_t \qquad (2a)$$

where $Y_{ij} =(lnX_{11}, \ldots, lnX_{NT})'$ is a (nx1) vector of exports; $X = (lnGDP_i, lnGDP_j, lndist_{ij}, lang_{ij}, landl_{ij}, lnMPS_i, lnMPS_j, NAFTA, EU)'$ is a (nxk) vector of independent variables; β is (k x 1) matching vector of unknown fixed parameters; $\varepsilon_t=(\varepsilon_{1t} \ldots \varepsilon_{1t})'$ is (n x 1) vector and is assumed to be independently and identically distributed (i.i.d) error terms; and $\mu= (\mu_1 \ldots \mu_N)'$ is (nx1) vector that captures the effect of the omitted variables of each spatial unit. I then expand the model by including the spatial interaction effects.

As previously mentioned, the spatial dependence can either include autocorrelated error terms and spatially lagged dependent variable. In the spatial lag form, the spatial dependence is similar to having a lagged variable as an explanatory variable to capture neighborhood spillover effects. In other words, a country' exports will be associated to those exports in its nearby countries. The formulation for the spatial fixed effects including spatially lagged variable or spatial lag and spatial fixed effects can be expressed as:

$$Y_{ij} = \rho W Y_{ij} + X\beta + \mu + \varepsilon_t \quad E(\varepsilon_t) = 0,\ E(\varepsilon_t \varepsilon_t') = \sigma^2 I_N \qquad (2b)$$

where ρ is the spatial autoregressive coefficient and assumed to lie between-1 and 1. It measures the degree of linear dependence between Y_{ij} and the weighted average of neighboring countries' exports. W is known as the "connectivity matrix" or first order spatial contiguity matrix. This matrix indicates the degree of interdependence between any two observations in the space in which W_{ij} =1 for any two countries sharing a common border, and 0 otherwise. W is a non negative matrix of dimension N x N and by convention the main diagonal of the matrix consists of zeros since a region i cannot be its own neighbor. The spatial weight matrix W is further row normalized, which means that the elements of each rows are transformed so that each of the rows sums to one, in order to keep its important property of symmetry to facilitate the interpretation of the coefficient (Anselin,1988). I should stress that W is assumed to be constant over time for estimation purposes. WY_{ij} is the spatially lagged dependent variable, Y_{ij} X , β , μ, ε_t are the same as in equation (2a).

In running the model, I begin by testing the statistical significance of the spatial autoregressive coefficient as follows:

H_0: ρ =0

H_0: ρ ≠0

Rejecting the null and running ordinary least squares (OLS) is equivalent to an omitted variable error. The consequence is that OLS coefficients estimates are biased and inconsistent and all statistical inferences are invalid. This is my preferred estimation strategy because it allows determining if there is a spillover effect of the market price support due to the interaction of countries through trade.

The second form of spatial dependence is the spatial error model which is the result of the non-spherical error covariance matrix. The formulation for the spatial fixed effects including spatial error autocorrelation is given by:

$$Y_{ij} = X\beta + \mu + \Phi_t \qquad (2c)$$

and the spatial error autocorrelation is reflected in the following error term:

$$\Phi_t = \lambda W \Phi_t + \varepsilon_t \qquad , E(\varepsilon_t) = 0, E\left(\varepsilon_t \varepsilon_t^{'}\right) = \sigma^2 I_N \qquad (2d)$$

where Y_{ij} X , W are defined in the same way as before, λ is the spatial autocorrelation coefficient and assumed to lie between -1 and 1. The coefficient λ measures the effects of neighboring shocks embodied in the error term (Bernat, 1996). Similarly, I run the model to test the statistical significance of the spatial autocorrelation coefficient as follows:

H_0: λ =0

H_0: $\lambda \neq 0$

If the parameter λ is statistically different from zero, ignoring the spatial dependence invalidate inferences based on OLS because coefficient estimates are no longer efficient but remains unbiased.

Another approach to test the spatial dependence is to include the spatially lag dependent variable and the spatially autocorrelated error term simultaneously, but the spatial weights matrix of both the spatial lag model and the spatial error must be different, or adopt an unconstrained spatial Durbin model to test whether the model can be simplified to one of the above specification (Ehorst, 2009). Although Kelejian and Prucha (1998) propose a generalized spatial two stage least squares procedure that use the same spatial weights matrix to estimate the parameters of the linear regression model that include a spatially lagged dependent variable and the correlated error terms, it is applicable on cross section data. Thus panel spatial econometrics remains a topic of further research. As an example, Anselin, Le Gallo and Jayet (2008) pointed out that apart from the routines in Matlab for panel data with spatial fixed effects developed by Elhrost (see http:// www.spatialeconometrics.com), the situation is bleak for panel spatial econometrics in general.

5.1. Data Description

The present study uses a balanced panel set for the gravity model and the spatial econometrics in the estimation of bilateral trade flows of processed sugar (SITC Rev.3 code 062). I use annual export flows taken from the United Nations Commodity Trade Statistics Database (UNCOMTRADE) that provides bilateral trade values and quantities of exports and imports by commodities and by partner countries under the Standard International Trade Classification system (SITC- Revision.3) between 21 OECD countries and Brazil from 1995 to 2007. Brazil is included in the analysis because it is the major sugar exporting country (USDA 2008) and also has data on the market price support. GDP data are from the World Bank Development Indicators, and information on distance, common language, contiguity, and landlocked are obtained from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII). The market price support (MPS) are drawn from the OECD Trade and Agriculture Directorate. The MPS is the market price differential between domestic market price and border price denominated in local currency units. The market price differential can be either positive or negative. A positive market price differential implies that government intervenes in the sugar market by stimulating production, hence raising domestic market price, while a negative sign of the market price differential suggests that less government intervention in the sugar market, resulting to lower domestic market price, thereby discouraging production as a consequence of taxing producers (OECD, 2010). The MPS is the annual monetary value of gross transfers from consumers and taxpayers to sugar growers expressed in million US dollar by using US$ exchange rate. For estimation purpose, Silva and Tenreyro (2006) point out that adding an arbitrary positive constant number to all observations in the presence of zero in the dependent variable lead to inconsistent estimators, because zero may be the result of rounding errors or wrongly recorded. Since I do not have any zero in my dependent variable, I replace the negative value of the MPS by zero and add one to all values. Table 1 presents the summary statistics of the variables.

5.2. Empirical Results

The spatial lag and spatial fixed effects model is my preferred estimation to be compared with the theoretically- motivated gravity model, although, I also report the results of the different specifications of the gravity model in Table 2, as well as the spatial error model in Table 3. The first two columns in Table 2 report results with the standard gravity model with no fixed or time effects and country-specific fixed effects (theoretical gravity model). The theoretically-motivated gravity model is presented in column 3. In column 1, all coefficients of the standard gravity model are statistically significant and have the correct signs with explanatory power of 51%. Even though coefficient estimates of exporter and importer market price support are statistically significant, the importer market price does not have the correct sign. However, these estimates are not reliable because of the omission of the multilateral price terms.

Column 2 shows a strong negative relationship between distance and trade which confirms a priori expectations in the standard gravity model. The variables language, border and landlocked have the expected sign and are statistically significant. The trade agreements are also statistically significant and positive. While the model has a high explanatory power at 82%, the importer market price support is positive and statistically significant. The results in column 3 take into account the endogeneity of a policy variable. The estimated coefficient of exporter market price support is negative and statistically significant. This result suggests that a reduction in the level of market price support provided to sugar growers benefits the processed sugar industries through the induced reduction in market prices of raw sugar. Consequently, a one percent decrease in the market price support in exporting countries increases refined sugar exports by 1.7 percent. The estimated coefficient of importer market price support is positive and statistically significant, indicating a higher market price support to sugar growers that increase the price of raw sugar for processed sugar industries. Thus, a one percent increase in the market price support in importing countries increases imports of refined sugar by 3.6 percent. This result is in line with Jayasinghe and Sarker (2008) who focused on agricultural trade of raw sugar rather than on refined sugar. However, the trade agreements are not statistically significant. The next section discusses the results of the spatial econometric models

5.3. Spatial Results

The spatial econometrics approach accounts for the interdependence among observations. The results for the spatial error model and the spatial lag model are presented in Table 3. The results in column 1-2 indicate the presence of spatial dependence and all estimated coefficients also are statistically significant with the correct sign except the exporter and importer market price support. The estimated coefficient λ is positive and statistically significant in column 1. This suggests that trade flow in one region is affected by the neighboring regions if these regions trade are above or below “normal” as predicted by the model (Bernat, 1996). In addition, the statistical significance of the autocorrelation coefficient indicates the presence of the non-spherical errors, suggesting a good model specification as opposed to OLS. The same finding holds in column 3 which included the spatial fixed effects, but the coefficients of exporter and importer market price support are statistically significant and have the correct sign. The estimated coefficient of ρ is positive and statistically significant in column 2, suggesting that trade in one region is affected by the performance of its neighbors exports.

The estimated coefficients in column 4 are compared with those of the theoretically-motivated consistent gravity model. For the spatial lag and spatial fixed effects model, the estimated coefficient of ρ is positive and statistically significant. This implies that a one percent increase in trade in one region causes a 0.45 percent increase of weighted average of the neighboring regions exports. This finding suggests that countries geographically close to each other are likely to intensify trade. The coefficient estimated of the exporter market price support is negative and statistically significant, indicating that a one percent reduction in the market price support in exporting countries leads to 0.8 percent increases in exports. The coefficient estimated of importer market price support is positive and statistically significant, suggesting that a one percent increase in the market price in importing countries increases the volume of imports of refined sugar by 0.6 percent. These findings suggest that the coefficients estimated of the theoretically motivated gravity model overstates trade flows because they fail to account for the spatial effects that capture the effects of EU and NAFTA, embodied in the spatially lagged dependent variable (Porojan, 2001). Moreover, NATFA and EU are positive and statistically significant. This indicates that being a member of the EU is associated with an average 122.58 percent ((exp(0.88)-1) x 100) increase in refined sugar export relative to non-members, whereas being part of NAFTA is associated with an average 2142 percent ((exp(3.11)-1) x 100) increase in refined sugar exports relative to non-members. This finding is consistent with Grant and Lambert (2008) who found that the average effect of RTA increases agricultural trade of members.

6. Conclusion

The primary purpose of this study is to access the effects of market price support on trade of refined sugar using the theoretically motivated consistent gravity and spatial econometric approaches in OECD countries over the period 1995-2007. The findings of this study suggest that reduction in the market price support could have had statistically significant and positive effects on refined sugar exports. Estimating the panel gravity model with bilateral pair and country by time fixed effects generates a 1.7% increase in refined sugar exports, while the spatial model lag increase refined sugar exports by 0.8%

It is evident that the presence of spatial dependency introduced in the form of spatially autoregressive dependent variable changes the magnitude and statistical significance of the estimated parameters. This finding justifies the use of appropriate spatial models in which the structure of the spatial dependency is embodied in the weighted matrix to assess the effects of regional trade agreements as well as policy questions. The empirical results of this study suggest that any appropriate effort to reduce market price support, particularly in OECD countries that heavily intervene in the sugar market will increase global trade of refined sugar.

Table 1. Descriptive Statistics of the variables from 1995-2007

Variables	Mean	Standard Deviation
Trade	1.13e+07	3.09e+07
GDP_i	1.16e+12	2.15e+12
GDP_j	1.93e+12	2.91e+12
MPS_i	1.42	0.22
MPS_j	1.40	0.24
Distance	5091.39	5018.97
Language	0.17	0.38
Border	0.16	0.37
Landlocked	0.07	0.26
NAFTA	0.02	0.15
EU	0.31	0.46

Figure 1. Analysis of the Market Price Support

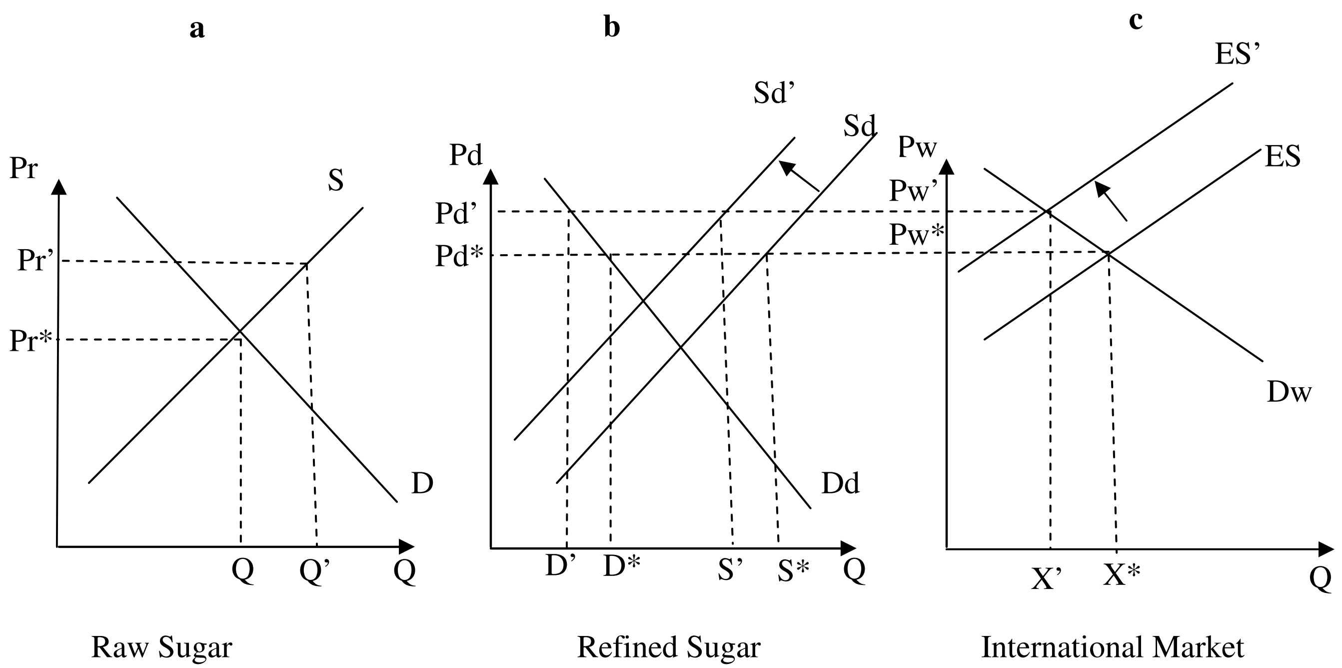

Table 2. Regression Results of the different Gravity Model Specification

Variables	*(1)* *No fixed or time effects*	*(2)* *Country-specific fixed effects*	*(3)* *Bilateral fixed and country-and-time effects*
GDP_i	0.59***	1.00[a]	1.00[a]
	(24.14)		
GDP_j	0.50***	1.00[a]	1.00[a]
	(20.61)		
$Dist_{ij}$	-0.87***	-0.77***	
	(-22.70)	(-15.69)	
$Lang_{ij}$	0.87***	0.74***	
	(10.32)	(7.81)	
$Border_{ij}$	0.42***	0.38***	
	(4.10)	(3.58)	
$Landl_{ij}$	-0.69***	-2.37***	
	(-5.36)	(-7.72)	
$NAFTA_{ij}$	0.66***	1.50***	-0.37
	(3.34)	(6.49)	(-1.18)
EU_{ij}	0.41***	0.22*	-0.31
	(4.82)	(1.86)	(-1.57)
MPS_i	0.61***	-0.61	-1.71***
	(3.35)	(-1.23)	(-2.94)
MPS_j	-1.21***	3.07***	3.65***
	(-6.06)	(6.03)	(6.66)
R^2	0.51	0.82	0.94
Adj R^2	0.50	0.78	0.92
N	2574	2574	2574

Notes: The numbers in parentheses are *t*-statistics; ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.
[a]Indicates unitary GDPs
Dependent variable in column 1 is log of (exports)
Dependent variable in column 2and 3 is exports divided by GDPs in log form

Table 3. Regression Results of the Spatial Econometrics

variables	*(1)* *Spatial error*	*(2)* *Spatial lag*	*(3)* *Spatial error and spatial fixed effects*	*(4)* *Spatial lag and spatial fixed effects*
GDP_i	0.45***	0.44***	1.00[a]	1.00[a]
	(25.66)	(25.52)		
GDP_j	0.36***	0.36***	1.00[a]	1.00[a]
	(19.16)	(19.18)		
$Dist_{ij}$	-0.94***	-0.93***		
	(-27.45)	(-27.23)		
$Lang_{ij}$	1.01***	1.00***		
	(12.61)	(12.50)		
$Landl_{ij}$	-1.01***	-1.03***		
	(-7.94)	(-8.06)		
$NAFTA_{ij}$	1.09***	1.08***	3.13***	3.11***
	(5.58)	(5.51)	(15.81)	(15.75)
EU_{ij}	0.22**	0.21**	0.85***	0.84***
	(2.51)	(2.50)	(10.99)	(10.92)
MPS_i	0.72***	0.69****	-0.76	-0.82*
	(3.92)	(3.78)	(-1.59)	(-1.78)
MPS_j	-0.83***	-0.84***	0.62***	0.61***
	(-4.17)	(-4.22)	(3.78)	(3.72)
λ	0.33**		0.52***	
	(2.53)		(5.57)	
ρ		0.01***		0.45***
		(3.09)		(4.81)
R^2	0.49	0.49	0.56	0.57
N	2574	2574	2574	2574

Notes: The numbers in parentheses are *t*-statistics; ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.
[a]Indicates unitary GDPs
Dependent variable in columns 1and 2 is log of (exports)
Dependent variable in columns 2 and 4 is exports divided by GDPs in log form

Chapter 2: Customs Procedures and Trade in a Heckman Sample Selection Model

1. Introduction

Trade costs as a determinant of international trade play an important role of getting a good to the final consumer (Anderson and Wincoop, 2004). These trade costs can be linked to domestic policy such as tariffs and limited market access, the physical distance (transport cost) between regions, and nontariff barriers (NTB). Despite these trade costs, the volume of world merchandise trade rose by 14 percent from 2007 to 2010 (WTO, 2010). One possible explanation for the increase of international trade is a reduction of tariffs and nontariff barriers, as well as the decline in transportation costs. For example, Baier and Bergstrand (2001) find evidence that the growth in OECD trade from 1950 to 1980 is explained by tariff reductions of about 25 percent, and transport cost declines of about 8 percent. A second possible explanation is the advancement of communication technologies and improvement in infrastructure as a consequence of decreasing communication and transport costs for differentiated goods (Tang, 2006). Nevertheless, the volume of international trade is reduced by hidden transaction costs associated with borders constraints (Anderson and Marcouiller, 2002). McCallum (1995) finds that border effect reduces the volume of trade between Canada-US despite their similarities.

The border effect is the cost of moving goods across borders and the elasticity of substitution between domestic and foreign goods that determine the gap between the price paid by buyers and sellers of traded goods, as well as the impact of the price differential on the amount imported as discussed by Pomfret and Sourdin (2010). Given the fact that crossing a border has the adverse effect of reducing trade, it is important to identity factors related to border procedures known as trade facilitation. Because of its importance to foster trade, trade facilitation is one of the issues raised in the WTO meeting at the Singapore Ministerial Meeting in 1996 and now in the Doha Development Round of negotiations. In a narrow sense, trade facilitation includes the quality of infrastructure (maritime, air, roads, rail, and telecommunication) and customs administration designed to evaluate the direct customs costs as well as administrative transparency of customs and border crossings (Wilson, Mann, and Otsuki, 2005). With this in mind, trade facilitation involves reducing transaction costs associated with the movement of goods across borders. For instance, transaction costs associated with crossing borders affecting international trade in some Central and Eastern Europe is estimated to be about six percent (Messerlin and Zarrouk, 2000).

The purpose of this chapter is to provide empirical evidence of the trade facilitation argument, in particular customs procedures taken by the Doha Development agenda negotiations on customs with the objective of increasing international trade. As the World Customs Organization (2011) notes, customs procedure play an important role on the economic competitiveness of nation to engage in international trade not only in providing reduction in delays and indirect costs associated with the movement of goods across borders, but also secure to tax revenues. Shorter processing time of goods at borders increase business opportunities by eliminating inventory holding and depreciation costs on traders (Walkenhorst and Yasui, 2009). For example, Engman (2009) argues that the lengthy waiting time to export is detrimental for the competitiveness of businesses in export industries in developing countries. Djankov, Freund and Pham (2010) estimate that if Uganda reduces its time to export from 58 to 27days, its export would increase by 31%. Thus, customs procedures on the time required for the release of goods is an important policy in support of trade facilitation to developing countries to be part of the global marketplace.

The rest of this chapter proceeds as follows. Section 2 reviews the literature on trade facilitation. Section 3 describes the methodology and data. Section 4 presents the estimation results. Section 5 concludes.

2. Literature Review

The empirical literature on trade facilitation identifies many factors with adverse effects of trade volume reduction such as cumbersome customs and port clearance procedures, burdensome regulatory requirements, as well as poor infrastructure and institutions. For example, Anderson and Marcouiller (2002) provide evidence that transaction costs associated with poor institutions, specifically legal systems capable of enforcing commercial contracts, transparency and impartiality, significantly reduce international trade. Building on the work by Anderson and Marcouiller (2002), Berkowitz, Moenius and Pistor (2006) apply the gravity model framework to evaluate the quality of institutions for 55 countries over the period 1982-1992. The authors show that strong legal institutions increase trade of complex products that are difficult to stipulate in a contract by lowering the transaction costs. Helble, Shepherd and Wilson (2009) provide evidence that the transparency of the trading environment through greater predictability and simplification reduces transaction costs by increasing trade.

Subsequent studies such as those by Nordås and Piermartini (2004), Limao and Venables, (2001), and Freund and Weinhold (2004) relate trade facilitation to the quality of infrastructure and information technology. Wilson, Mann, and Otsuki (2003) within the gravity model estimate the impact of four measures of trade facilitation (port efficiency, customs environment, regulatory environment, and service sector infrastructure) on trade over APEC members from 1989 to 2000. They find that improving all trade facilitation indicators positively impact trade by reducing trade costs, but improvement in port efficiency has the strongest positive effect on intra-APEC trade.

Nordås and Piermartini (2004) use the gravity model to evaluate the quality of infrastructure on trade, and provide evidence that better quality of infrastructure lowers transportation costs with a positive impact on bilateral trade flows, in particular time sensitive sectors such as clothing and automobiles. Limao and Venables (2001) within the gravity model estimate the quality of infrastructure on trade. They find that poor infrastructure account for 40% of transportation costs for coastal countries and 60% for landlocked countries. In addition, the authors conclude that the quality of infrastructure account for much of Sub-Saharan poor export performance because of the high transport costs. Using U.S. Department of Transportation data on maritime transport costs, Clark, Dollar and Micco (2004) estimate the effect of port efficiency on maritime transport costs, and find that the poor seaport infrastructure increase transport costs. For instance, they show that if a country like Peru or Turkey decreases its seaport's inefficiencies to a level similar to Iceland or Australia, it would be able to increase trade by about 25%.

Freund and Winhold (2004) measure trade facilitation through the level of information technology, focusing on the number of internet hosts per country. Using a model with imperfect competition and fixed costs of entry in to a foreign market because they are important for a large share of trade in goods. They find that a 10 percent increase in the number of web hosts in one country would have led to about 1 percent increase in trade flows from 1997 to 1999. In addition, the authors conclude that development in information technology explains trade growth over this period because fixed costs associated with trade decrease. Furthermore, Wilson, Mann and Otsuki (2005) take a broader approach to evaluate information technology which measures the extent to which a country has the necessary network information (telecommunications, financial intermediaries and logistic firms) on trade. Using a gravity model, they find that improvement in information technology will generate $ 154 billion increase in global trade.

Other studies link trade facilitation to customs and administrative procedures such as the time a good spends in transit (time to export and time to import) which is the focus of this paper. Hertel, Walmsley and Itakura (2001) apply the Computable General Equilibrium Model to evaluate the impact of removal of tariffs, common standard for ecommerce, and automating customs procedure clearance for 17 regions, particularly trade between Japan and Singapore. They find that customs automization has the biggest impact on trade between Japan and Singapore as well as with the rest of world due to the reduction of cost of dispatching information and documents to ensure security of associated documents. Hummels (2001) examine time as a trade barrier using data on ocean shipping time for 1999 that include information on modal choice (air versus ocean). In order to capture the shipping time, he posits tariff as equivalent to an additional day's travel time, and find that each day saved in shipping time is equivalent to 0.8% tariff which means on average that 20 days of shipping by sea is equivalent to a 16% tariff.

Djankov, Freud and Pham (2010) use a difference-in difference gravity equation to evaluate the effect of time delays on trade by choosing exporters with similar location and factor endowments, and show empirically that each additional day a product is delayed prior to being shipped reduces trade by more than 1%. Nordås, Pinali and Geloso Grosso (2006) explore the relation between time for exports and imports, logistics services and trade, and find that time delays reduce the volume of international trade and the probability that firms will enter export markets for time sensitive products. While these studies examine the importance of time as a trade barrier, these studies have failed to accurately capture the presence of the zero valued trade flows, hence ordinary least squares(OLS) results suffer from a downward bias. This study differs from the above studies and contributes to the literature through the application of a Heckman sample selection model that allows a complete decomposition of the volume of trade into the intensive and extensive margins to investigate time as a trade impediment.

3. Methodology and data

In spite of the popularity of the gravity model to explain trade patterns, there are serious concerns as to its correct specification. For instance, Feenstra (2002) shows that the use of fixed effects for each exporting and importing country to take account of the unobserved price indexes yield consistent estimates. However, Flowerdew and Aitkin (1982) argue that in the presence of zero trade value, the conventional logarithm specification of the gravity model violates the assumption that error terms are normally distributed with equal leading to biased and inefficient estimates. They suggest the Poisson model to handle zero flows and avoid the bias in the estimates of the logarithm transformation.

Silva and Tenreyro (2006) point out that to circumvent zero flows, either exclude observations with zero flows from the data or add a positive small number (1) to all observations in order to permit the log-linear formulation. However, this procedure leads to inconsistent estimates due to the log-linearization in the presence of heteroskedasticity. They propose the use of Poisson Pseudo Maximum Likelihood (PPML) method using Monte Carlo Simulations, and find that PPML generates robust estimates in the presence of heteroskedasticity. Moreover, the

PPLM method provides a natural way to deal with zero flows. Similarly, Burger, van Oort and Linders (2009) state that the zero inflated Poisson model specification circumvent the zero-valued trade flows, and gives both the probability of countries trading and the probability of trade volume given specific factors.

In contrast, Linders and De Groot (2006) argue that the Heckman (1979) sample selection model is appropriate both theoretically and econometrically because it allows zero flows and the size of potential trade to be explained jointly. As Jayasinghe, Beghin and Moschini (2009) note, the sample selection model takes into account the changes in exogenous variables on both the likelihood of trade (extensive margin) and the existing volume of trade (intensive margin). This approach is applied in the present chapter.

The standard gravity model posits that the volume of trade between two countries is positively related to their levels of income reflecting the market size in both countries, and negatively related to the distance between them which represent transport costs. As is usual in the literature, I extend the gravity model with dummy variables that foster bilateral trade: common language, regional trade agreement, contiguity, and colonial ties, as well as trade cost dummy variable represented by landlocked countries. I also include variables of particular interest, required time for exports and imports in multiplicative form. These are measures of trade facilitation that I expect to be negatively related to trade. Finally, I use the country–specific fixed effects of the gravity equation that interact sector level trade data and country fixed effects to account for the unobserved price index at the sector level as in Disdier, Fontagne and Mimoun (2008). Thus, the empirical gravity equation estimated is:

$$ln\left(\frac{X_{ijt}}{GDP_{it}GDP_{jt}}\right) = fe_i + fe_j + \alpha_0 + \alpha_1 lndist_{ij} + \alpha_2 ln(days_{ijt})$$

$$+ \alpha_3 lang_{ij} + \alpha_4 cont_{ij} + \alpha_5 landl_{ij} + \alpha_6 col_{ij} + \alpha_7 RTA_{ij} + \varepsilon_{ijt} \qquad (1)$$

where j and i stand for the importer and exporter respectively, and t denotes a year. The dependent variable has two components; X_{ij} is bilateral import from country j to country i; and GDP_i and GDP_j are the gross domestic product of exporting and importing countries. The variable ($days_{ijt}$) reflects the number of days to export multiplied with the number of days to import ($days_{it}$*$days_{jt}$). The distance between pairs trading ($dist_{ij}$), and dummies indicating whether i and j: have the same language ($lang_{ij}$), share a common land border($cont_{ij}$), have a colonial relationship(col_{ij}), are both members of the regional trade agreement(RTA_{ij}) take the value of 1, and 0 otherwise. Landlocked ($Landl_{ij}$) equals 1 if one of the trade partner is landlocked, 2 if both partners are landlocked, and 0 otherwise. The error term ε_{ijt} is assumed to be normally distributed, and fe_i *and* fe_j are the set of importer, exporter, and sector trade data "fixed effects".

Estimating the above log-linear formulation of the gravity equation in the presence of zero-valued trade flows using ordinary least squares (OLS) will bias the results because the logarithm of zero is undefined as a consequence of excluding zero flows from the effective sample. As Felbermayr and Kohler (2006) remark, zero bilateral trade flows contain valuable information which may reflect mis-reporting and mis-measurement, particularly small and poor countries. To address this issue, I use the Heckman two –step procedure that posits two equations, the selection equation and the trade equation. Let Y_t denotes the vector of the LHS of equation (1), and $Z_{ijt} = ln\left(\frac{X_{ijt}}{GDP_{it}GDP_{jt}}\right)$. The Sample selection model of bilateral trade is specified as follows:

The selection equation:

$$S_{ijt} = fe_i + fe_j + \alpha_0 + \alpha_1 lndist_{ij} + \alpha_2 ln(days_{ijt})$$

$$+\alpha_3 lang_{ij} + \alpha_4 cont_{ij} + \alpha_5 landl_{ij} + \alpha_6 col_{ij} + \alpha_7 RTA_{ij} + \alpha_8 ln(cost_i * cost_j) + \mu_{ijt} \quad (2)$$

where

$$S_{ijt} = 1\ if\ Z_{ijt} > 0\ and\ S_{ijt} = 0\ if\ Z_{ijt} \leq 0$$

and the trade equation:

$$\bar{Y}_{ijt} = fe_i + fe_j + \alpha_0 + \alpha_1 lndist_{ij} + \alpha_2 ln(days)$$

$$+\alpha_4 lang_{ij} + \alpha_5 cont_{ij} + \alpha_5 landl_{ij} + \alpha_6 col_{ij} + \alpha_7 RTA_{ij} + \varepsilon_{ijt} \quad (3)$$

where

$$Y_{ijt} = \bar{Y}_{ijt}\ if\ S_{ijt} = 1\ and\ Y_t = not\ observed\ if\ S_{ijt} = 0$$

where $\mu_{ijt} and\ \varepsilon_{ijt}$ have a bivariate normal distribution with zero means, standard deviation σ_ε and σ_μ, and ρ the correlation between $\mu_{ijt}$and ε_{ijt}. $Cost_i$ and $cost_j$ represent exporter and importer costs associated with completing the procedure to export or import. Now let us assume that trade is observed, thus the sample selection model to be estimated is:

$$Y_{ijt} = X_t\beta + \rho\sigma_\mu \frac{\phi(W_t\gamma)}{\Phi(W_t\gamma)} + \nu_t \quad (4)$$

where $W_t\ and\ X_t$ represent the exogenous variables, and β and γ are unknown parameter vectors of equations (2) and (3) respectively; ϕ and Φ are the standard normal density function and the standard normal distribution function of equations (2) and (3); $\phi\,(W_t\gamma)/\Phi(W_t\gamma)$ is the selectivity regressor called the inverse Mills ratio with coefficient $\rho\sigma_\mu$ (Davidson and Mackinnon, 1993).

The Heckman's two step procedure works as follows. In the first stage a probit model is used to produce consistent estimates of the parameters of the selection equation to determine the probability that trade occurs between two countries. In the second stage, the inverse Mills ratio is included as an additional explanatory variable in the trade equation estimated by ordinary least squares to generate consistent estimates (Hoffman and Kassouf, 2005). The trade equation assesses the amount of trade that occurred between two countries. In order to implement the Heckman's two step procedure, Helpman, Melitz and Rubinstein (2008) argue that the model need to be over-identified , achieved by including at least one variable in the selection model that affects fixed trade costs but not the volume of trade, and does not appear in the outcome equation or trade equation. Their work points out that costs faced by both exporting and importing countries satisfy this condition, therefore, the interaction term costs will be my excluded variable in my estimation.

4. Data Description

The data used in this chapter are from the World Bank survey called "Doing Business" in the section *Trading Across Borders* that generates a metric of customs and administrative procedures for 183 countries. The survey put together procedural requirements for exporting and importing a standardized cargo of goods by contacting local freight forwarders, shipping lines, customs brokers, and port official on the necessary documents, costs, and time to cross the border.

The documents include customs and clearance, as well as official documents signed between exporter and importer. The time to cross the border (number of days) is the number of calendar days for a product to cross the border. In the 2006 survey, Doing Business introduced costs measures that include all costs associated with completing the procedures to export or import a product in a 20-foot container in U.S. dollars, but do not include tariffs or trade taxes. The survey also makes assumptions about the traded goods to make it comparable across countries. The traded product travels in a dry cargo, 20-foot full container load, is not hazardous, and does not require refrigeration or any special environment. It also does not require any special phytosanitary or environmental safety standards other than accepted international standards. The goods are coffee, tea, cocoa, spices and manufactures thereof (SITC, 07), textile, yarn, fabrics, and made-up articles (SITC, 65), and articles of apparel and clothing accessories (SITC, 84). Trading Across Borders indicators are available annually, however, it should be noted for instance that data on Doing Business 2008 reflects survey conducted from June 2006 to May 2007.

The trade data are bilateral import taken from the United Nations Commodity Trade Statistics Database (UNCOMTRADE). GDP data are from the World Bank Development Indicators, and information on distance, colony, common language, contiguity, common land border, and landlocked are obtained from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII). GDP data are not available for 27 of 183 countries for which I have data on documents, costs, and time to cross the border, so these data cover all trade from 156 countries from 2006 to 2008.

Table1 presents summary statistics of customs and administrative procedure for the regions of the world. In Sub-Saharan Africa, on average it takes 34.6 days and $ 1805 to export a standard container of goods, while in OECD countries it takes on average 11.1 days and $ 1015 to export an identical good. For all these indicators, Sub- Sahara Africa is worst of all continents, indicating trade passes through excessive and inefficient customs and administrative procedures.

5. Empirical Results

The estimation results are displayed in Table 2. Model (1), column1 estimates come from the standard ordinary least squares (OLS) of the log-linear specification for which trade flows are non-zero. Model (2) reports results with the Heckman's two step procedure estimated by ordinary least squares (OLS) to account for zero-valued trade flows to correct for sample selection bias in OLS estimators.

Columns 2-3 present the results for the outcome and selection equations, while columns 4-5 report the conditional marginal effects evaluated at the sample means. The conditional marginal effects provide the elasticities of trade given that trade takes place (intensive margin), and the unconditional marginal effects represent the elasticities on both intensive and extensive margins of trade for all countries trading and not trading in the sample (Jayasinghe, Beghin and Moschini, 2009). However, I will focus on the conditional marginal effects to estimate the potential gain of trade facilitation.

Beginning with model (1), parameter estimates of the standard gravity variables are statistically significant at the 1% level and have the correct signs except the variable landlocked that does not have the correct sign although it is statistically significant. These findings are in line with the existing literature. Distance exerts a negative effect on bilateral trade flows, whereas common language, colonial relationship, RTA, and common land border positively affect bilateral trade flows. The coefficient estimate on days is negative and statistically significant which suggests that relative delays decrease the amount of trade flows.

Results from the selection equation show that all parameters have the correct sign and are statistically significant at the 1% level except for the variable landlocked, implying that being a landlocked country does not affect the probability of trading. On the other hand, distance, days, and costs decrease the likelihood of trading while common language, common land border, RTA, and colony increase the probability of trading.

The comparison between columns (1) and (2) indicates some similarities. For instance, the variable landlocked although statistically significant has the opposite sign. However, the magnitude of the coefficient estimates are significantly affected in absolute value by the choice of the estimation procedure in the presence of zero flows. As evidence, the statistically significance of the inverse Mills ratio ($\hat{\lambda}$) from the selection equation illustrates the sample selection bias in the OLS estimates in the outcome equation. The coefficient estimate of distance increases in absolute value from -1.11 in OLS to -1.4 in Heckman, and is statistically significant at the 1% level. The coefficient estimates of dummies for common language, RTA, colony, and common land border are larger in the Heckman than in OLS, and are statistically significant at the 1% level. The coefficient estimate of days increases from -1.00 in the OLS to -1.7 in the Heckman, and is statistically significant at the 1% level. These findings confirm that OLS underestimates the true value of the parameter estimates when dealing with zero-valued trade flows.

Columns 4-5 report the conditional marginal effects of the outcome and selection equations. All of the coefficient estimates in those equations have the correct sign and are statistically significant at the 1% level except the variable landlocked that does not have the expected sign. On the magnitude of trade effects, the statistical significance of days implies that a 10% reduction in relative delays increases relatively the amount of trade by about 8%. This finding is consistent with Djankov, Freud and Pham (2010) who find that 10% reduction in relative delays increases relative exports by 4% for exporters that are similar in location and factor endowments, and face the same trade barriers in foreign markets.

To further investigate the benefit of trade facilitation, I use disaggregate data of the three products, since the time at the border depends on the product and the export destination. In addition, some goods are more time sensitive than others because of the higher costs associated with long time delays at the border, particularly textile and apparel (Nordås, Pinali and Grosso, 2006). To that end, I run the sample selection model including only the exporter and importer fixed effects to derive the conditional marginal effects.

Table 3 presents the results of the conditional marginal effects. The parameter estimates for days is negative and statistically significant at the 1% level, as well as provide information about the magnitude of the coefficient estimates. Comparing across the three products at the intensive margin, days has the strongest impact on coffee, tea, cocoa, spices and manufactures thereof, suggesting the most time- sensitive of all three products. A 10% reduction in relative delays increases agricultural trade (column1) by about 7.3% compared to about 7.1% in trade of articles of apparel and clothing accessories (column3). This consistent with Engman (2009) who states that the perishability of agricultural products generate losses associated with delays. Additionally, being landlocked reduces the likelihood of trading. Textile, yarn, fabrics, and made-up articles (column2) are time-insensitive because it has the lowest statistical significance, and a 10% reduction in relative delays increases relative trade by about 4.5%, suggesting a greater reduction in relative delays to promote trade. This result is in line with Wilson (2009) who finds that to achieve a 10% increase in trade of textile yarn, fabrics, and made-up articles, Brazil has to reduce its time at the border by 4.04 compared to 2.86 for trade of coffee tea and spices.

Distance impacts the trade volume and the probability of trading of textile, yarn and made-up articles more than the others. Similarly, being a landlocked country also decreases the likelihood of trading of textile, yarn and made-up articles. Interestingly, having colonial ties increases the probability of trading of coffee, tea, cocoa, spices and manufactures thereof. Finally, on the magnitude of trade effects, the coefficient estimate of distance is bigger in absolute value than days across all three products, implying reduction in relative delays may compensate for geographical distance. Overall, these results provide evidence of the benefit of trade facilitation.

As robustness check of my results, I run the sample selection model without the interaction of export time and import time on the whole sample and the disaggregated data (SITC, 07). The same result holds for the other two commodities. Table 4 and 5 present the conditional marginal effects of this alternative approach.

In Table 4, all parameters of the standard gravity model have the anticipated signs and are statistically significant at the 1% level for the trade equation. The coefficient on export time is negative and statistically significant at the 1% level, implying that 10% reduction in the time to export increases exports by about 25%. Surprisingly, the coefficient on import time does not have the correct sign although statistically significant. In column 2, the coefficient estimate on import time is negative and statistically significant, implying that required time for import affect the likelihood of trading. The combined results from the trade and the selection equations suggest that time to export significantly impact the volume of trade as well as the probability of trading, while the time to import decrease the likelihood of trading.

The results of the disaggregate data in Table 5 show that both export time and import time significantly decrease the amount of trade. Additionally, most of the signs of the other variables remain unchanged and are statistically significant. Thus, I can conclude that the model specification is adequate.

6. Potential Benefits of improving customs procedures: Simulation Results

Results from the sample selection model show that relative delays reduce the volume of trade. From a policy point of view, it is important to improve customs procedure to increase trade. To provide evidence, I re-estimate the sample selection model on the sub-sets of country bilateral trade, particularly intra Sub –Sahara Africa (SSA) trade, intra South Asia and Latin America and Caribbean trade (SA&LAC), SSA- OECD trade, SSA- SA& LAC trade, and SA&LAC-OECD trade. Table 6 provides the conditional marginal effects of the sub- panels.

In column 1, relative delays for intra –SSA reduce the value of trade by about 1.18 percent. Distance has a significant negative impact on trade, while the remaining variables have no impact on trade. In column 4, relative delays reduce the amount of trade by about 0.88 percent, whereas sharing a common border, having a colonial relationship, and belonging to an RTA boost intra- SA& LAC trade. The common language and landlocked variables have the opposite sign. Comparing column 1 and 4, for example a 10% reduction in relative delays would increase intra-SSA trade by about 11.8% and intra-SA& LAC by about 8.8 %, suggesting that poor customs procedures have a bigger impact on intra –SSA trade. This finding is in line with Wilson, Mann and Otsuki (2003) who find that improvement in customs procedures increase intra-APEC trade.

In column 2, distance has a statistically and negative effect on trade, so does the time to export which reduces the volume of export by about 1.05%. However, the statistical significance of the coefficient estimate on import time is unexpected, because it takes less time for OECD to import, suggesting a better customs procedures than SSA. The remaining variables have no impact on trade. In column 3, time to export has a significant and negative effect on reducing SSA exports by about 1.69%. Surprisingly, the estimated coefficient on import time is statistically significant. Distance and landlocked negatively impact the volume of trade, and the common language and colony variables are positively associated with trade. Comparing column 2 and 3, the biggest loss of SSA export is toward SA& LAC countries because of the large absolute value of time to export compared to OECD countries.

In column 5, the coefficient estimate of the time to export for SA& LAC has a statistically and negative impact on reducing trade by about 3.19 percent. A 10% reduction in required time for export would increase trade by about 31.9% toward OECD countries. The coefficient estimate of the time to import is statistically insignificant, indicating that OECD countries had already reduced the required time for import from these countries. The variables colony and RTA are statistically significant and positively affect trade. The coefficient estimate of common language is statistically significant but it has the opposite sign. The variable landlocked is negative and statistically significant, indicating that being landlocked as well as distance reduce the amount of trade. These results suggest that Sub –Saharan Africa and South Asia and Latin America and Caribbean can enhance trade by improving their customs procedures with the greatest required improvement in this area is in Africa.

7. Conclusion

The present study uses the Heckman sample selection model to estimate the benefit of trade facilitation measures as time to export and import based on the sample of 156 countries over the period 2006-2008. The results show that OLS underestimates the parameters in the presence of zero-valued trade flows which can result in misleading conclusions.

I find that a 10% reduction in relative delays is associated with an increase of 8% in the volume of trade, suggesting that more efficient customs regulations would speed the process of a product crossing a border. However, I show that relative delays vary across industries. My results indicate that a 10% reduction in relative delays yield about 7.3% increase in bilateral trade on time-sensitive products.

Finally, as a policy implication, these results support the importance of trade facilitation reform as a key element to promote regional and global trade. The simulation analysis suggests that governments need to improve administrative procedures, improve physical infrastructure, and have a network of communications to reduce the time required to export or import. In particular, African countries would especially benefit as it takes on average 34.6 days to export and 41 days to import a standardized cargo.

Table 1. Regional Averages

Region	Document to export	Time to export	Cost to export	Document to import	Time to import	Cost to import
Regional Averages						
Sub-Sahara Africa	7.8	34.6	1805	8.82	41	2190
East and South Asia	7.4	26.2	1028	8.1	27	1113
Latin America and Caribbean	6.9	20.5	1190	7.3	23.61	1371
OECD	4.4	11.1	1015	5	11.9	1075
Middle East	6.3	18.6	890	7.7	21.9	1094
Eastern Europe and Central Asia	6.8	31.6	1647	8.2	33.3	1852
World Summary Statistics						
Average	6.7	24.9	1344	7.6	27.9	1550
Standard Deviation	2.2	16.3	778.2	2.4	19.0	961.9

Table 2. OLS on Log-Linear Model and the Heckman's two step procedure

		(2) Heckman's two step method			
		Coefficient estimates		Marginal effects	
Model	OLS	Trade equation	Selection equation	Trade equation	Selection equation
	(1)	(2)	(3)	(4)	(5)
Constant	19.80*** (0.193)	24.44*** (0.244)	9.42*** (0.137)		
ln (distance)	-1.11*** (0.164)	-1.40*** (0.191)	-0.44*** (0.006)	-0.77*** (0.021)	-0.37*** (0.006)
ln (days)	-1.01*** (0.023)	-1.70*** (0.032)	-0.62*** (0.007)	-0.82*** (0.033)	-0.50*** (0.007)
Common border	1.02*** (0.063)	1.16*** (0.662)	0.44*** (0.030)	0.55*** (0.077)	0.49*** (0.031)
Common language	0.60*** (0.035)	0.78*** (0.363)	0.26*** (0.011)	0.41*** (0.039)	0.25*** (0.010)
Landlocked	0.29*** (0.058)	0.26*** (0.573)	0.02 (0.153)	0.23*** (0.061)	0.03*** (0.010)
Colony	1.09*** (0.069)	1.45*** (0.730)	0.63*** (0.374)	0.59*** (0.087)	0.75*** (0.045)
RTA	1.03*** (0.049)	1.06*** (0.507)	0.46*** (0.022)	0.41*** (0.059)	0.35*** (0.014)
ln(cost exporter* cost importer)			-0.18*** (0.009)		-0.03*** (0.001)
Mills ratio ($\hat{\lambda}$)		1.7*** (0.052)			
R^2	0.66				
Observations	77272	77272	143156		

Notes: Fixed effects not reported. Standard error appear in parentheses and ***,**, *denotes significance at 1% , 5 %, and 10% level.

Table 3. Heckman's two step procedure with disaggregated data

Variables	SITC 07 Trade equation	SITC 07 Selection equation	SITC 65 Trade equation	SITC 65 Selection equation	SITC 84 Trade equation	SITC 84 Selection equation
ln(distance)	-0.871***	-0.015***	-1.202***	-0.09***	-0.920***	-0.061***
	(0.0340)	(0.0013)	(0.0295)	(0.0045)	(0.0280)	(0.0035)
ln(days)	-0.729***	0.002	-0.453***	-0.0005	-0.716***	-0.011*
	(0.1753)	(0.0022)	(0.1439)	(0.0087)	(0.1389)	(0.0066)
Common border	0.327***	0.027***	0.381***	0.027***	0.361***	0.045***
	(0.1092)	(0.0052)	(0.1026)	(0.0104)	(0.1076)	(0.0109)
Common language	0.392***	0.021***	0.402***	0.094***	0.701***	0.085***
	(0.0642)	(0.0022)	(0.0551)	(0.0065)	(0.0550)	(0.0063)
Landlocked	7.808***	-0.032***	-0.446	-0.118***	1.394**	-0.640***
	(1.2977)	(0.0046)	(0.7396)	(0.0122)	(0.6522)	(0.0395)
Colony	0.877***	0.033***	0.687***	0.016	0.802***	0.013
	(0.1229)	(0.0074)	(0.1223)	(0.0121)	(0.1293)	(0.0105)
RTA	0.211**	0.014***	0.211***	0.081***	0.183**	0.104***
	(0.0883)	(0.0016)	(0.0809)	(0.0072)	(0.0839)	(0.0143)
ln(cost exporter*		0.002		-0.008		-0.004
cost importer)		(0.0018)		(0.0071)		(0.0058)

Notes: Fixed effects not reported. Standard error appear in parentheses and ***,**, *denotes significance at 1% , 5 %, and 10% level. SITC 07: coffee, tea, cocoa, spices and manufactures thereof; SITC 65: textiles, yarn, fabrics and made-up articles; SITC 84: articles of apparel and clothing accessories.

Table 4. Conditional Marginal Effects of the full sample

Variables	Trade equation	Selection equation
ln(distance)	-0.77*** (0.02)	-0.07*** (0.0012)
ln(export $_{time}$)	-2.56*** (0.04)	-0.11*** (0.0018)
ln(import)$_{time}$	0.65*** (0.03)	-0.11*** (0.0018)
Common border	0.57*** (0.07)	0.11*** (0.088)
Common language	0.41*** (0.03)	0.05*** (0.003)
Landlocked	-0.42*** (0.06)	0.002 (0.0028)
Colony	0.57*** (0.08)	0.156*** (0.012)
RTA	0.35*** (0.06)	0.11*** (0.007)
ln(cost exporter*cost importer)		-0.31*** (0.001)

Notes: Fixed effects not reported. Standard error appear in parentheses and ***,**, *denotes significance at 1% , 5 %, and 10% level.

Table 5. Conditional Marginal Effects of disaggregated data

	SITC 07		SITC 65		SITC 84	
Variables	Trade equation	Selection equation	Trade equation	Selection equation	Trade equation	Selection equation
ln(distance)	-0.871***	-0.015***	-1.202***	-0.089***	-0.921***	-0.059***
	(0.0339)	(0.0006)	(0.0295)	(0.0029)	(0.027)	(0.0023)
ln(export $_{time}$)	-0.733***	0.005	-0.453*	0.014	-0.654***	-0.004
	(0.2756)	(0.0033)	(0.1439)	(0.0131)	(0.2157)	(0.0106)
ln(import $_{time}$)	-0.737***	-0.00002	-0.471**	-0.135	-0.785***	-0.018*
	(0.2666)	(0.0029)	(0.2098)	(0.124)	(0.2072)	(0.01001)
Common border	0.327***	0.027***	0.381***	0.027***	0.361***	0.035***
	(0.1092)	(0.005)	(0.1027)	(0.0103)	(0.1076)	(0.01001)
Common language	0.392***	0.022***	0.401***	0.094***	0.701***	0.084***
	(0.0642)	(0.0017)	(0.0551)	(0.0058)	(0.0549)	(0.0053)
Landlocked	12.030***	-0.327***	5.860***	-0.708***	5.966***	-0.639***
	(1.2851)	(0.0223)	(0.5285)	(0.0138)	(1.1928)	(0.0164)
Colony	0.877***	0.033***	0.687***	0.016	0.802***	0.015
	(0.1228)	(0.0072)	(0.1224)	(0.0121)	(0.1293)	(0.0107)
RTA	0.211**	0.013***	0.210***	0.081***	0.183**	0.067***
	(0.0883)	(0.0013)	(0.0809)	(0.0072)	(0.0839)	(0.0054)
ln(cost exporter*		0.003		-0.008		-0.005
cost importer)		(0.0017)		(0.0071)		(0.006)

Notes : Fixed effects not reported .Standard error appear in parentheses and ***,**, *denotes significance at 1% , 5 %, and 10% level. SITC 07: coffee, tea, cocoa, spices and manufactures thereof; SITC 65: textiles, yarn, fabrics and made-up articles; SITC 84: articles of apparel and clothing accessories.

Table 6. Conditional Marginal Effects of the Potential Benefits of Customs Procedure

Variables	Intra-SSA (1)	SSA-OECD (2)	SSA-SA&LAC (3)	Intra-SA&LAC (4)	SA&LAC-OECD (5)
lndistance	-0.755***	-1.089***	-2.198***	-0.602***	-0.259***
	(0.211)	(0.200)	(0.493)	(0.843)	(0.132)
ln(days)	-1.176***			-0.878***	
	(0.343)			(0.179)	
ln $export_{time}$		-1.055***	-1.690***		-3.198***
		(0.227)	(0.569)		(0.137)
ln$import_{time}$		0.482**	2.416***		0.543
		(0.188)	(0.710)		(0.144)
Common border	0.270			0.556**	
	(0.359)			(0.235)	
Common language	0.003	0.219	1.838***	-0.749	-0.943***
	(0.266)	(0.165)	(0.393)	(0.197)	(0.181)
Landlocked	0.535	-0.153	-0.406	1.595***	-0.231***
	(0.378)	(0.231)	(1.368)	(0.418)	
colony	1.313	-0.087	0.63***	7.030***	1.371***
	(1.913)	(0.087)	(0.374)	(1.720)	(0.254)
RTA	-0.298			1.636***	3.141***
	(0.300)			(0.229)	(0.930)

Notes: Fixed effects not reported. Standard error appear in parentheses and ***,** ,* denotes significance at 1% , 5 %, and 10% level

Chapter 3: Foreign Direct Investment and Trade in a Simultaneous Spatial Panel Model

1. Introduction

Foreign direct investment (FDI) and international trade are often seen to promote economic growth. Foreign direct investment (FDI) has grown at a faster rate than most international transactions, in particular bilateral trade flows between countries (Blonigen, 2005). According to UNCTAD (2009) world FDI inflows reached a historic high of $1.9 trillion in 2007, but with a sharp decline estimated to 15% in 2008 due to the global economic slowdown in a number of major economies.

FDI is a cross border investment of "lasting interest" undertaken by multinational corporations in an existing enterprise when the direct investor owns at least 10% of the voting power (OECD, 2010). It is a valuable source of capital allowing the introduction of new technology, and stimulating domestic investment as well as facilitating improvements in the competitiveness of domestic firms by providing advanced managerial skills (Balasubramanyan et al. 1996).

Multinational corporations (MNCs) making investment decisions in a foreign country can be explained either by the market access motive or the comparative advantage motive. The first motive is known as the proximity concentration trade-off and refers to horizontal FDI in which a MNC production facility is designed to serve customers in the foreign market to avoid higher transport costs and trade barriers (Brainard, 1997). The second motive of MNC arises to exploit international factor price differentials by engaging in unskilled labor-intensive production in an unskilled labor-abundant host country, referred as vertical FDI (Baltagi, Egger, and Pfaffermayr, 2007). Thus, the motivation for horizontal and vertical FDI depends on country characteristics such as factor endowments as well as trade and investments costs. However, Markusen and Maskus (2002) find that horizontal FDI is more important in the world economy than vertical FDI because most FDI flows are from high income countries to other similar high income countries.

Additionally, both types of MNC investment decisions have implications on the host country. For example, host countries benefit from horizontal FDI through higher productivity by raising output, employment, and exports (Girma, Greenaway and Wakelin, 2001). Moreover, host countries take advantage of the spillover effects related to backward and forward linkages between MNC and domestic firm via labor training (Blomstrom and Kokko, 1998). On the other hand, vertical FDI may compress the skilled wage differential and change the income distribution on host countries (Aizenman and Marion, 2004).

Direct investment by MNCs may also be a hybrid of both horizontal and vertical FDI known as complex FDI which is a function of parent and host countries characteristics such as the level of transport cost, the factor intensity of production, and the cost of investing abroad, as well as host neighbors policies and characteristics (Yeaple, 2003). Complex FDI strategies fragment production between parent and host country to serve the home market or “third market”.

The purpose of this chapter is to analyze the relationship between FDI and exports, specifically whether FDI and exports are complements or substitutes, and identify the presence of complex FDI. The proximity–concentration trade off hypothesis states that firms invest abroad when the gains from avoiding trade costs outweigh the advantage from production scale economies (Brainard 1997). Therefore, direct investment as a consequence of distance substitute trade. On the other hand, complementary of FDI and trade suggest that the spillover effects on MNC on the productivity of local firms in host countries resulting from vertical FDI.

Given the surge in spatial econometric techniques is fairly recent in FDI literature, few studies have tested the importance of third country effects (Blonigen et al., 2007, Baltagi, Egger and Pfaffermayr, 2007; Garretson and Peeters, 2009). However, no study to date has analyzed the relationship between FDI, trade, and the presence of complex FDI in a simultaneous equation framework. The present chapter contributes to the existing literature through the development of the application of the Generalized Spatial Two Stage Least squares (GS2SLS) model developed by Kelejian and Prucha (2004) extended to a simultaneous spatial panel data. Before doing so, I investigate the spatial dependence of outward FDI stock to test the presence of complex FDI by applying the spatial autoregressive technique and compare it to Blonigen et al. (2007).

The remainder of this chapter proceeds as follows. Section 2 presents the review of relevant literature. Section 3 introduces the model and the empirical specification. Section 4 presents the data and empirical results. Section 5 concludes.

2. Literature Review

2.1. Relevant literature on FDI without space

A large body of literature exists concerning the relationship between FDI and trade, yet the debate is inconclusive as to whether FDI complements or substitutes with trade. For example Pfaffermayer (1994) applies a time series technique to study the relationship between outward FDI and exports of Australian firms, and finds a complementary relationship between FDI and exports. Clausing (2000) empirically investigates the relationship between U.S. multinational activity and trade in 29 host countries from 1977 to 1994. He provides evidence of a complementary relationship between multinational activity and trade. He concludes that government actions to discourage one activity may simultaneously discourage the other.

Brainard (1997) applies the gravity model to test the proximity-concentration trade-off hypothesis between multinational sales and exports with bilateral FDI flows and exports with three digit SIC data. He finds a complementary relationship between multinational activities and exports because affiliate sales and exports are increasing in market size and in intellectual property advantages. Co (1997) applies a probit model to analyze the relationship between Japanese FDI and trade over the period 1974-1992. Co finds that FDI and trade are complements. Jenson (2002) explores the relationship between FDI and exports in Poland, and finds that FDI and trade are complements in the labor intensive sector. Wilson (2006) applies the gravity model to investigate the relationship between FDI and trade in OECD countries. He finds a complementary relationship between imports and inward FDI.

Marchant, Saghaian, and Vicker (1999) use a simultaneous equation to examine U.S. agricultural food exports and FDI for the Chinese processed food market. They find that exports and FDI are complementary, consistent with the literature for developing countries.

Subsequent literature on FDI and trade find that FDI and trade are substitutes, or there is a presence of both substitute and complementary relationship between FDI and trade. For example, Belderbos and Sleuwaegen (1998) analyze Japanese manufacturing FDI and electronics exports in Europe using data from 1982-1991. They use a logit model to provide evidence of the strong substitution effect between exports and FDI for Japanese manufacturers. Gopinath, Pick and Vasavada (1999) use a four equation system to investigate the relationship between FDI and trade in U.S. food industries. The authors indicate that FDI and exports are substitutes in the U.S. processed food industries.

Ma, Morikawa, and Shone (2000) investigate Japanese outward FDI into developed and developing countries with data from 1975-1990. Their error correction model shows that trade and FDI are substitutes in developed countries and complements in developing countries for Japanese FDI. Blonigen (2001) utilizes industry level FDI inflow from Japan to the U.S. from 1980-1990, and finds substantial evidence of the presence of both substitute and complementary relationships between trade and FDI.

Egger and Pfaffermayr (2004) utilize bilateral industry level exports and outward stocks of FDI from the U.S. and Germany to other OECD and non OECD countries between 1989 and 1999 to investigate the relationship between distance, trade and FDI. In a seemingly unrelated regression Hausman-Taylor model, they show that exports and FDI may be substitutes or complements with respect to distance, depending on relative factor endowments. They conclude that exports and outward FDI are complementary with respect to distance in the U.S. but are substitutes in Germany.

Pain and Wakelin (1998) analyze manufacturing exports and inward and outward stocks of FDI among 11 OECD countries from 1971 to 1992 data. In an augmented export demand model, they provide evidence of the heterogeneity in the linkages between FDI and exports. Their findings suggest that outward FDI has a negative impact on home country export performance, while inward FDI has a positive effect on the host country export.

More recently, the literature on FDI has recognized the importance of third country effects to explain multinational investment decisions. That is to say a home country invests in a particular host country with the intention of serving "third markets" with exports of final goods from the affiliate in the host country (Blonigen et al. 2007). As pointed out by Neary (2009), the two country models cannot explain the relationship between FDI and trade due to trade liberalization and falling trade costs. He argues that the spatial as well as the temporal dimensions of FDI must be taken into account to understand why FDI falls rather than rises with distance.

Garretsen and Peeters (2009) recommend that geography or spatial interdependencies have to be included in the analysis of FDI to take into account how agglomeration economies may arise with FDI patterns captured by the market potential variable that includes not only market size (GDP) of the host country but also the distance weighted GDPs of other locations. The market potential variable has been put forth by Harris (1954) and it is important to identify additional market demands that are not included in two country models. In their study of Japanese manufacturing FDI flows into the European Union, Head and Mayer (2004) derive a market potential measure for country pairs, and find that the spatial distribution of Japanese investment is correlated with the market potential.

2.2. Related Literature on Spatial Patterns of FDI Theory

There are a few empirical studies that incorporate spatial econometrics in FDI studies to investigate the importance of third country effects. Coughin and Segev (2000) are the first to use spatial econometric techniques to examine US FDI flows into 29 Chinese provinces from 1990-1997 (Blonigen et al. 2007). They test both the spatial error model and the spatial autoregressive model. Their spatial autoregressive model indicates that increased FDI in one province has positive effects on FDI in nearby provinces.

Baltagi, Egger, and Pfaffermayr (2007) use bilateral outward FDI stocks and foreign affiliate sales (FAS) at the industry level over the period 1989-1999 to investigate third country effects. They augment their spatial autocorrelation with spatially weighted exogenous variables to capture the third country effects using a spatial panel data with spatially correlated error components suggested by Kapoor, Kelejian, and Prucha (2007). They find evidence of the presence of complex FDI, leading to the importance of third country effects.

Blonigen et al. (2007) utilize industry level U.S. outbound FDI data into 35 host countries from 1983-1998 applying the spatial autoregressive model to test the importance of spatial interactions in empirical FDI studies estimated by maximum likelihood methods. They argue that ignoring the spatial interdependence in cross country FDI estimations causes omitted variable bias, and provide evidence of export-platform FDI for most industries within the developed European countries. Gerretsen and Peeters (2009) analyze Dutch outbound FDI into 18 OECD host countries for the period 1984-2004 to investigate the third country effects. In a spatial autoregressive model, they find support of the presence of complex vertical FDI with agglomerations economies.

3. Model and Empirical Specification

3.1. Importance of Spatial Econometrics in FDI Studies and Trade

Spatial econometrics has been extensively applied in studies on cross-sectional data to identify the presence of externalities or spillover effects as well as to generate unbiased and consistent estimates (Anselin, 1988). As noted by Anselin (2009) ignoring spatial econometrics in empirical studies results either in omitted variables bias, leading to biased and inconsistent estimates, or to inefficient estimates. However, the empirical literature to expand these models to panel data that incorporate the role of space and time in explaining FDI patterns is not well documented (Blonigen et al. 2007).

Blonigen et al. (2007) mention that the importance of spatial econometrics, in particular the estimated coefficient of the spatial autoregressive term in FDI studies, assesses the cotemporaneous correlation between one region's FDI and the other geographically proximate region's FDIs. In addition, the underlying decisions to invest in a particular country depends on the size of the proximity markets it will be serving through exports, what is known as the surrounding market potential (the market potential variable). The market potential variable for region i is the accessibility of market j to goods shipped from country i (Head and Mayer, 2004). Moreover, the omission of third country effects of the determinants of FDI may lead to biased parameter estimates (Baltagi, Egger, and Pfaffermayr, 2007). Finally, the interpretation of the coefficient of the spatial autoregressive term and the market potential variable identify MNC investment strategies: vertical FDI, horizontal FDI, export platform FDI, and complex vertical FDI (Garretson and Peeters, 2009). The results are summarized in Table1.

Horizontal FDI by MNC is motivated by the market access motive known as the proximity-concentration trade-off hypothesis which predicts that firms expand production horizontally across borders to avoid high trade costs and take advantage of production of scale economies (Brainard 1997). In this situation, there is no spatial relationship between FDI and market potential because MNC make independent decisions about which markets to enter through exports or affiliate sales, with zero entries for the spatial lag coefficient and the market potential variable (Blonigen et al., 2007).

A vertical FDI decision by MNC arises from the international difference in relative factor endowments due to factor prices difference between home and host countries by shifting activities to the lowest cost locations (Helpman, 1984). Since vertical FDI is driven by factor cost differences between countries, the spatial lag coefficient is expected to be negative because FDI from home country d to host country i will be at the expense of FDI going into other regions (Blonigen et al. 2007). On the other, the market potential variable should not be relevant since goods produced in host countries are more likely to be shipped to the home country (Baltagi, Egger, and Pfaffermayr, 2007).

Export platform FDI refers to a situation where a MNC located in home country d set up a production plant in country i, with exports from i to the third market j, arising from the lower transport costs between i and j , and a high transport cost between d and i (Baltagi, Egger, and Pfaffermayr, 2007). As pointed out by Neary (2009) export-platform is always a gain for MNCs because the decision to locate a production plant depends not only on the size of the host country market but also on the size of the intended market to serve. The expectation is a positive sign for the potential market variable. The coefficient of the spatial autoregressive is expected to be negative since MNC serving a third country j through exports from i is more efficient from a single location. This suggests that an increase in FDI in the third country j would result in a decrease in FDI to country i (Garretsen and Peeters, 2009).

Complex vertical FDI is driven by the difference in relative factor endowments and the involved production plant in host country i and third country j with exports from j to home country d (Baltagi, Egger, and Pfaffermayr, 2007). Due to several firms located to each other, positive externalities or spillover from FDI into countries i and j produce agglomeration economies, suggesting a positive sign of the coefficient of autoregressive (Blonigen, et al. 2007).

The market potential variable would be positive if it captures the agglomeration effects, and otherwise 0 if it takes into account demand or market size (Garretsen and Peeters, 2009). The demand of the market potential is the attractiveness of the third country j relative to country i for MNCs in country d, measured in terms of GDP (Baltagi, Egger, and Pfaffermayr, 2007). Figure 1 illustrate export platform FDI.

On the other hand, the importance of the spatial autoregressive model in the trade equation is to capture the cross sectional interdependence across trade flows, controlling for multilateral resistance as in Anderson and Wincoop (2003) to generate unbiased and consistent parameter estimates (Behrens, Ertur, and Koch, 2007).

As noted above, recent empirical studies on the determinants of FDI support evidence of interdependencies across countries. However, the point of departure of this study is that I investigate the relationship between FDI stocks and exports simultaneously controlling for spatial dependence. This approach yields consistent parameter estimates and is superior to the ordinary least squares that uses instrumental variables because of the difficulty of finding appropriate instruments, that is exogenous variables that have a direct effect on FDI but do not belong in the export equation. Also it provides support of whether FDI and exports are complements or substitutes and captures the third country effects of FDI and trade flows among host countries as well. Therefore, the proposed modeling addresses the empirical challenges of the two stage least squares that relies on instrumental variables which fail to simultaneously explain the relationship between FDI and trade when there is a spatial dependence between observations. Additionally, this approach demonstrates the weakness of the gravity model by using the weighted distance in the sample to understand the spatial distribution of FDI.

3.2. Empirical Specification

Following Blonigen et al. (2007), I use the spatial autoregressive model to test the presence of complex FDI. Next I develop a simultaneous system of equations to analyze the relationship between U.S. outward FDI stock and exports, as well as to test third country effects. The third country effects are important if trade costs are reduced between countries i and j and the distance between i and j is small (Baltagi, Egger, and Pfaffermayr, 2007). Thus, I construct an inverse distance weight matrix based on the smallest distance between i and j. Also, the third country effects are captured by the market potential variable that includes not only the GDP of FDI host country but also the inverse distance weight matrix weighted by the GDPs of other locations (Garretsen and Peeters, 2009). However, Blonigen et al. (2007) argue that the market potential measure of Head and Mayer (2004) that includes host GDP may influence the results by increasing the size of the significance of the estimated coefficients. I will come back to the construction of the inverse distance weight matrix and the market potential variable.

A modified gravity model specification is applied since it is a commonly used empirical specification of FDI and trade (Brainard, 1997), suggesting the standard gravity model variables for the analysis. While the negative effect of distance on trade in the gravity model has been confirmed, the impact of distance on FDI is ambiguous. As noted by Markusen (2002) the theory of multinational firms does not offer much about the prediction of distance because it is an element in both export cost and investment and monitoring costs by raising transactions costs of investments and export costs. I expect host GDP to be positively related to FDI because of the convergence in income level between the U.S and its trading partners (Markusen and Venables, 2000). Host country's population is expected to be negatively related to FDI because an increased in population reduces GDP per capita discouraging FDI. I include skilled labor endowments which I expect to be positively related to FDI because MNCs build plants in skilled labor abundant countries that require skilled labor intensive activities (Markusen and Maskus, 2002). With regard to host countries trade costs, if FDI motive is to exploit factor differences between parent and host countries, then higher trade costs reduce FDI. By way of contrast, if FDI motive is to avoid higher transport costs, then higher trade costs encourage FDI. Therefore, the sign of host countries trade costs is ambiguous. Dummy variables indicating whether home and host country: have the same language (lang), have a colonial relationship (col) take the value of 1, and 0 otherwise, are expected to stimulate FDI. Following Baltagi, Egger and Pfaffermayr (2008), I include NAFTA, a dummy variable taking the value of 1 if both home and host countries are member of the regional trade agreement and 0 otherwise which I expect to be positively correlated with FDI.

An inverse distance matrix $W_y(d_{i,j})$ identifies the geographical relationship among host countries by dividing each observation by the shortest bilateral distance. The matrix W_y is symmetric and time invariant. The shortest distance in my sample is 173.033 km, separating Belgium and Netherlands that receives a weight of unity and all other distances within the sample a weight that declines as follows:

$$W_y(d_{i,j}) = \frac{173.033}{d_{i,j}} \quad \forall\, i \neq j \tag{1}$$

where W_y is a matrix of all $W_y(d_{i,j})$ defined as:

$$W_y = \begin{pmatrix} 0 & W_y(d_{i,j}) & W_y(d_{i,k}) \\ W_y(d_{j,i}) & 0 & W_y(d_{j,k}) \\ W_y(d_{k,i}) & W_y(d_{k,j}) & 0 \end{pmatrix} \tag{2}$$

As is standard in spatial econometrics, the inverse distance matrix is row standardized so that each row sums to unity. The market potential variable is defined as the row sum of the product inverse distance weight matrix and the vector of all host GDP countries in the sample (Blonigen et al, 2007). It should be noted that the inverse distance matrix does not need to be standardized to compute the market potential variable. Combining all elements, I specify the following spatial autoregressive model where all variables are in natural logs except dummy variables:

$$FDI = \alpha_0 + \rho W_y FDI + \alpha_1 GDP + \alpha_2 Dist + \alpha_3 POP + \alpha_4 host\ skilled + \alpha_5 Trade\ costs + \alpha_6 market\ potential + \alpha_7 Nafta + \varepsilon \quad (3)$$

and the spatial simultaneous system of equation as follows:

$$exports = \alpha_0 + \rho(I \otimes W_y) exports + \alpha_1 FDI + \alpha_2 GDP + \alpha_3 dist + \alpha_4 lang + \alpha_5\, col + \mu_1 \quad (4)$$

$$FDI = \alpha_0 + \rho(I \otimes W_y) FDI + \alpha_1 Exports + \alpha_2 GDP + \alpha_3 PoP + \alpha_4 market\ potential + \alpha_5 dist + \alpha_6 Nafta + \mu_2 \quad (5)$$

where

$$\mu_1 = \overline{U}_1 R + E_1 \quad and \quad \mu_2 = \overline{U}_2 R + E_2 \quad (6)$$

where ε is the error term; W_y is the inverse distance weight matrix of dimension nxn which is the same in all equations; ρ is the spatial autoregressive coefficient to be estimated assumed to lie between -1 and 1; μ_1 *and* μ_2 are the disturbance of the spatial error; R is taken to be a diagonal matrix; $\overline{U}_1$ *and* $\overline{U}_2$ are the spatial lag of the spatial error that follows an autoregressive process in the disturbances; and E_1 *and* E_2 are the error terms. I is the identity matrix of dimension T, and $\otimes$ is the Kronecker product. Since the W_y is row standardized, then $W_y FDI$ and $(I \otimes W_y)FDI$ is interpreted as row-sums being a proximity-weighted average of FDI into alternative countries (Blonigen et al., 2007), and $(I \otimes W_y)exports$ is the weighted average of neighboring countries exports (Porojan, 2001).

Equation (3) is estimated by the maximum likelihood technique since the dependent variable appears in the exogenous variable, while estimating equations (4) and (5) require an instrumental variable since FDI and trade are endogenous. To circumvent this issue, Kelejian and Prucha (2004) point out that the inverse distance weight matrix defined above as well as the exogenous variables in each equation represent an instrument matrix for estimation purposes. Moreover, in a linear simultaneous equation model, Greene (2003) states that the order condition, which is a necessary but not a sufficient condition, requires that the number of exogenous variables excluded from one equation must be at least as large as the number of dependent variables included in that equation. Thus the order condition of my system is fulfilled because (4) excludes two variables, while (5) excludes three variables.

Finally, the simultaneous system of equation is estimated by a generalized spatial two stage least squares in three step procedure. In the first step the equations are estimated by two stage least squares (2SLS) using the inverse distance weight matrix as an instrument. In the second step, the autoregressive parameter ρ is estimated by the generalized method of moments procedure introduced in Kelejian and Prucha (1999). In the third step, the estimate for ρ accounts for the spatial autocorrelation in a Cochran–Orcutt transformation.

4. Data and empirical results

4.1. Data

The empirical analysis is performed with a panel of annual data on U.S. Direct Investment Abroad into 25 OECD host countries[1] taken from the U.S Bureau of Economic

[1] Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea,rep, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom

Analysis (BEA) covering the period 1999-2007. The sample period is chosen in order to test the presence of complex FDI and compared to Blonigen at al. (2007). However, it should be noted that data on host country investment costs measured as operations risk index, political risk index and remittance and repatriation factor index developed by Business Environment Risk Intelligence are not included due to monetary constraints. Next, I investigate the relationship between FDI and trade as well as to assess the presence of complex FDI using data from 1999-2009 for 24 OECD countries, because of missing data on GDP for New Zealand. The U.S. Direct Investment Abroad is U.S. outward direct investment stock measured at the historical cost basis expressed in millions of dollars of operations of parent companies and their foreign affiliates (BEA, 2011).

Human capital or host country skill is from Barro and Lee dataset on educational attainment in the World from 1950 to 2010, and measured average years of schooling for those 25 years and older reported every five years. I use a linear interpolation method for the missing years. Trade costs are measured by the inverse of openness which itself equal to exports plus imports divided by GDP obtained from the Penn World Tables (Blonigen et al., 2007). Trade data are total exports from the United Nations Commodity Trade Statistics Database (UNCOMTRADE) under the Standard International Trade Classification system (SITC-Revision.3). Host countries GDPs and population data come from the World Bank's World Development Indicators (WDI). Distance, language, and colony data are drawn from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).

I chose U.S. outward direct investment to OECD countries for two reasons. First, this allows me to test the third country effects by isolating vertical FDI, since horizontal FDI is more prevalent among industrialized countries (Aizenman and Noy, 2006). Second, as noted by

Blonigen and Wang (2004), pooling rich and poor countries in empirical FDI studies is inappropriate, leading to misleading results. Table 2 provides summary statistics of the variables.

4.2. Empirical Results

The estimation result of the spatial autoregressive model from equation (3) is presented in Table 3. In column 1, I add a time trend and a time trend square as in Blonigen et al. (2007) for comparison, while column 2 is augmented with NAFTA. The inclusion of NAFTA in the model is motivated by the fact that a regional trade agreement can stimulate FDI since transactions costs such as taxes and trade protection barriers have been reduced among countries. In coulumn1, the variables GDP, population, distance, and trade costs have the expected sign and are statistically significant at the 1% level. The coefficient of the spatial lag is positive and statistically significant, implying the presence of complex FDI. The coefficient of the market potential is negative and statistical significant. This finding is in line with Blonigen et al. (2007) and suggests the importance of spatial distribution of U.S. FDI into OECD countries. This result corroborates the validity of the specifications of the spatial econometric in empirical FDI studies.

Turning to column 2, I augmented the spatial autoregressive model with NAFTA. The variables of the standard gravity model have the correct sign and are statistically significant at the 1% level. The positive and statistically significant of the spatial lag suggests the presence of complex FDI which is consistent with Blonigen et al. (2007). However, the market potential comes up statistically insignificant. The variable NAFTA is statistically significant at the 1% level, suggesting that being part of the regional trade agreement fosters FDI. Trade costs have a negative and statistical significance on FDI. As noted by Blonigen et al. (2007) the inclusion of the host GDP in determining the market potential may overstate the coefficient estimates. I reran the regression with the market potential without the host GDP. The coefficients on the market potential and NAFTA variables are statistically insignificant while the coefficients on other variables did not change. The results are displayed in Appendix.

Next I investigate the relationship between FDI and trade and test for the presence of complex FDI using data from 1999 to 2007 and the same variable as in the spatial autoregressive model estimated by the generalized spatial two stage least squares. This is done to assess the robustness of the findings in the simultaneous framework. The estimation results are displayed in Table 4. From this Table, I conclude that the results do not hold since the standardization of the weight matrix bound the coefficient of the autoregressive term by -1 and 1 (Dubin, 2009). This leads me to my preferred system of simultaneous equation specification of equations (4) and (5) using 24 OECD countries from 1999-2009, and variables I believe to be important in examining the relationship between FDI and trade, and the spatial interdependence of FDI as well. Results are presented in Table 5. Column1 displays the result of the FDI equation, while column 2 shows the results of the export equation. Beginning with column (1), the coefficient on GDP and population have the expected sign and are statistically significant at the 1% level. The positive sign of GDP indicates that the larger the economic size of an economy, the greater potential to attract FDI, while a negative coefficient on population suggests that lower capital stock per worker available for production, ceteris paribus, discourages FDI.

The market potential is positive and statistically significant at the 1% level, suggesting that FDI from the U.S. into OECD countries is a function of the surrounded countries (distance weighted GDP matrix) with relatively large GDP levels. A positive and statistical significant spatial autoregressive coefficient indicates the presence of the spatial interdependence in the data, implying positive externalities of FDI. This result means that an increase of FDI in one region will increase FDI of the proximity regions. As I discussed above, the testable hypotheses based on the coefficient of the spatial autoregression and the market potential confirm the presence of complex FDI with agglomeration economies. This result is in line with Garretsen and Peeters (2009) who support this finding for Dutch FDI into OECD countries. However, this finding is in contrast with Blonigen et al. (2007) who found export platform FDI for OECD countries. The coefficient estimate of export is positive and statistically significant at the 1% level. This result suggests a 1% increase in exports causes FDI to increase by 0.59%. There is a complementary relationship between U.S. FDI and exports for OECD countries. This result is consistent with findings in Clausing (2000) who finds a complementary relationship between U.S. FDI and exports to OECD countries.

Column 2 presents the result for the export equation. With regard to the relationship between FDI and exports, the positive statistical significance of FDI reinforces result from column 1. The parameter estimate suggests that a 1% increase in FDI causes a 0.25% increase in exports, a complementary relationship between FDI and exports. The coefficient estimate of the spatial autoregressive term is positive and statistically significant at the 1% level. This implies that a 1% increase in export causes a 0.72% increase of the proximity weighted average exports of host countries. The parameter estimate on GDP positively influences exports while distance negatively impacts exports. This is consistent with the standard gravity model. Language has clear strong effect of attracting U.S. exports. The coefficient estimate of colony is statistical significant, but has the opposite sign. Overall the estimation results in Table 5 provide evidence of the importance of spatial interdependence in the data because the spatial lag coefficient is statically significant in both equations.

5. Conclusion

The present chapter assesses the implications of spatial dependence of U.S. FDI into OECD countries to test the importance of third country effects. I examine the relationship between U.S. FDI and exports to OECD countries. I also identify the presence of complex FDI by estimating a generalized spatial two stage least squares model developed by Kelejian and Prucha (2004) extended to a panel data. The use of the spatial econometrics points out the importance of third country effects to understand the determinants of FDI. Both estimation procedures confirm the presence of complex FDI by MNCs which are neither purely horizontal nor purely vertical integration.

However, the results of the simultaneous equation suggest that agglomeration economies are the result of complex vertical FDI that account for difference in relative factor endowments. This implies that investment by MNCs is a function of country characteristics as well as characteristics of its neighbors in attracting FDI. The empirical results for the FDI equation show a complementary relationship between FDI and trade. The empirical results for exports also indicate complementary relationship between FDI and trade. This finding indicates that host countries will benefit from attracting FDI to gain from spillover effects in order to improve productivity.

Table 1. Summary of hypothesized spatial lag and the surrounding market potential variable

FDI motivation	Sign of spatial lag	Sign of surrounding- market potential variable
Horizontal FDI	0	0
Vertical FDI	-	0
Export Platform	-	+
Complex FDI	+	0/+

Source: Baltagi et al. (2007) and Blonigen et al. (2007)

Figure 1. Export Platform FDI where the circle represents countries d, i and j

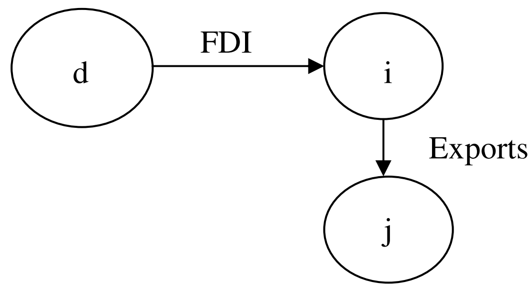

Table 2. Descriptive statistics of the variables from 1999 -2009

Variable	Mean	Std. Deviation	Minimum	Maximum
FDI (in millions)	60384.11	85157.61	760	449521
Trade (in thousands)	2.23e+07	3.88e+07	274241.2	2.22e+08
GDP(in millions)	685205	1015066	18691	5201164
POP (in millions)	34101.63	34430.4	430	127773
Distance(in km)	6407.889	2128.246	548.39	14546.24
MP(in millions)	1894279	1234849	165960.4	5942495
Language	0.13	0.34	0	1
Colony	0.12	0.32	0	1
NAFTA	0.83	0.27	0	1

Notes: MP is the market potential

Table 3. Spatial autoregressive model using data from 1999-2007

Variables	(1)	(2)
GDP	1.54***	1.54***
	(12.66)	(12.74)
Host country skill	0.01	-0.08
	(0.02)	(0.22)
Trade cost	-0.80***	-0.71***
	(-3.82)	(-3.15)
Pop	-0.81***	-0.86***
	(-7.51)	(-7.48)
Distance	-0.82***	-0.70***
	(-8.09)	(-5.22)
Market Potential	-0.17*	-0.14
	(-1.75)	(-1.33)
NAFTA	–	0.62**
		(2.02)
Time	0.03	0.02
	(0.29)	(0.25)
Time2	-0.001	-0.00008
	(-0.16)	(-0.07)
ρ	0.43***	0.37***
	(4.24)	(3.38)

Notes: T statistics are in parentheses. ***, **,* Significant at the 1%, 5% and 10% level

1. R^2/log-likelihood 0.64/ -311.75
2. R^2/log-likelihood 0.63/ -312.59

Table 4. Generalized spatial Two Stage Least Squares using data from 1999-2007

Variables	FDI	Export
Constant	-8.51*** (-3.36)	-5.22*** (-2.64)
GDP	0.75*** (4.57)	0.91*** (22.69)
Pop	-0.64*** (-6.19)	-
Trade costs	-0.24 (-1.18)	-
Host country skill	-0.07 (-0.21)	-
Distance	-0.38** (-2.09)	-0.53*** (-6.97)
Market potential	-0.02 (-0.24)	-
Language	-	0.62*** (5.23)
Colony	-	-0.76*** (-5.68)
NAFTA	-0.51 (-1.01)	-
Export	0.54*** (5.77)	-
FDI	-	0.21*** (6.02)
ρ	1.04*** (8.19)	0.77*** (6.02)

Notes: T statistics are in parentheses; ***,**, * significant at the 1%, 5% and 10% level.

Table 5. Generalized Spatial Two Stage Least Squares using data from 1999-2009

Variables	FDI (1)	Exports (2)
Constant	-9.24*** (-3.78)	-3.91** (-2.37)
GDP	0.67*** (4.72)	0.89*** (25.22)
Population	-0.66*** (-7.11)	-
Distance	-0.38** (-2.09)	-0.64*** (-8.22)
Language	-	0.32*** (2.52)
Market potential	0.20** (2.26)	-
Colony	-	-0.74*** (-6.09)
NAFTA	-0.17 (-0.35)	-
Exports	0.59*** (6.41)	-
FDI	-	0.25*** (8.10)
ρ	0.81*** (6.88)	0.72*** (7.00)

Notes : T-statistics are in parentheses. ***, **,* Significant at the 1%, 5% and 10% level.

Appendix
Spatial autoregressive model with market potential without GDP

Variables	(1)	(2)
GDP	1.50***	1.49***
	(12.96)	(12.94)
Host country skill	-0.03	-0.06
	(-0.07)	(-0.16)
Trade cost	-0.67***	-0.54***
	(-3.88)	(-2.72)
Pop	-0.81***	-0.85***
	(-7.35)	(-7.36)
Distance	-0.87***	-0.74***
	(-9.24)	(-4.92)
Market potential	-0.11	-0.03
	(-1.26)	(-0.36)
NAFTA	-	0.50
		(1.19)
Time	0.02	0.01
	(0.21)	(0.15)
Time2	-0.00009	0.0007
	(-0.008)	(0.06)
ρ	0.35***	0.33***
	(3.28)	(3.01)

Notes: Asymptotic T statistics are in parentheses. ***, **,* Significant at the 1%, 5% and 10% level

1. R^2/log-likelihood 0.64/ -312.64
2. R^2/log-likelihood 0.63/ -313.44

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