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TRADE ANALYSIS OF SPECIFIC AGRI-FOOD COMMODITIES USING A GRAVITY MODEL

By

Cristóbal A. Aguilar

A THESIS

Submitted to
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TRADE ANALYSIS OF SPECIFIC AGRI-FOOD COMMODITIES USING A GRAVITY MODEL

ABSTRACT

By

Cristobal Aguilar

This thesis explores the use of a gravity model (GM) to evaluate the determinants of trade for specific products defined at the 8-10 digit SITC-level. Frozen tart cherries (FTC) are used as an empirical example, allowing for estimation of the determinants of international trade and evaluation of trade potential among the largest exporters and importers of this specific good. Given statistical characteristics of the data, a Tobit model with fixed effects using panel data estimated by MLE is used as the estimation procedure.

Results indicate both income and output effects are positive with a significant influence on trade values. A marginal analysis of the model shows FTC trade value is income elastic. According to results of the country-pair fixed effects analysis, a common border, trade agreement and historical trade relationships all contribute to establishing trade partners. The results of this study can generate insights for policy-makers who address needs in specific local markets which are impacted through strong global linkages.

This thesis is dedicated to my beautiful children Anika and Joaquin
and to my unconditional partner, Valeria

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And of course, thanks to my family for being my base.

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ACRONYMS

AIC	Akaike's Information Criterion
AUS	Austria
AUT	Australia
BEL	Belgium
CAN	Canada
CES	Constant Elasticity of Substitution
DEN	Denmark
EU	European Union
FRA	France
FTA	Free Trade Agreement
FTC	Frozen Tart Cherries
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GDP-PPP	Gross Domestic Product Expressed in Terms of Purchasing Parity Power
GER	Germany
GM	Gravity Model
GRE	Greece
GSP	General System of Preferences
H-O	Heckscher-Ohlin Model
HUN	Hungary
ISIC	International Standard Industrial Classification
ITA	Italy
JAP	Japan
LR-Test	Log-likelihood ratio test
MEX	Mexico
MLE	Maximum Likelihood Estimator
NED	Netherlands
OLS	Ordinary Least Squares
POL	Poland
SITC	Standard International Trade Classification
SME	Small and Medium Enterprises
TUR	Turkey
UK	United Kingdom
U.S.	United States
WTO	World Trade Organization

CHAPTER I

1. Introduction

1.1 Background and Motivation

International trade is a field that has been studied broadly and one in which researchers have covered a wide range of topics. Yet, most of the empirical studies deal with aggregated variables and address issues from the perspective of a country-level or a sectorial level within a country. Empirical studies of international trade that address particular issues of a specific subsector or a particular commodity are less common. Empirical analysis of international trade for specific products is an angle of international trade which has received little attention.

The lack of attention to this trade topic may be explained, in part, by the shortage of readily available information prior to the 1990s, although efforts are still limited. For instance, Harrigan (1994) analyzed intra-industry trade using 3-digit International Standard Industrial Classification (ISIC) data. This level of aggregation classifies agriculture (excluding forestry) into five categories such as livestock, crop production and fishing or hunting. Lee and Swagel (1997) used a lower level of aggregation studying the effects of trade barriers across countries and industries using 4-digit ISIC data. At the 4-digit level, the food manufacturing industry is classified into categories such as slaughtering, dairy products, canned goods and fruit preserves, and grain mill products. Compared with aggregate trade volumes, these 3- and 4-digit international trade studies provide richer information to policy makers who want to address a particular sector, and to producer groups of high volume trade commodities such as tomatoes, oranges, and apples.

Still, when it comes to a very specific product (e.g. cabbage, marmalades, mushrooms, pears, tart cherries, 8 – 10 digit Standard International Trade Classification, SITC), previous studies are still too general and results cannot be applied to decision making in specific subsectors. Even though contributions of a specific agri-food subsector may seem marginal at a national level, their importance to the economy at a local level cannot be neglected. Subsectors like these play a key role in creating up-stream and down-stream linkages that generate economic opportunities at the local level.

This study explores the use of a gravity model (GM) to evaluate the determinants of trade for specific products (8-10 digit SITC). The GM, analogous to the gravity law, is based on the fundamental premise that trade between two countries is directly proportional to the size of their economy and inversely proportional to the distance between them. The application of the GM in international trade was initially developed by Tinbergen (1962) and independently by Pöyhönen (1963). The GM has also been used in areas such as migration flow analysis (Karemera, et al, 2000); foreign direct investment (Brenton, et al, 1999; Frankel and Cavallo, 2004); and market area analysis (Baker, 2000).

Use of the GM in international trade at an aggregate level has been extensive: examination of bilateral trade, (Prentice et al, 1998); block trade analysis, (Carrillo and Li, 2002; Martinez-Zarzoso & Nowak-Lehmann, 2003); multilateral trade agreements, (Rose, 2002); trade policy analysis, (Wall, 2000); estimation of trade potential, (Pravorne et al, 2003); hypothesis testing such as the Linder Hypothesis (McPherson, 2001) and border effect (McCallum, 1995; Wall, 2000). But, despite its multiple uses, there is a lack of information about the econometric specification of a GM to analyze international trade when it comes to a specific disaggregate commodity.[1]

An example of a disaggregated traded commodity sector with important local economic impacts is the tart cherry industry in Michigan. Approximately 70 percent of all U.S. production takes place in Michigan. Total farm-gate cash receipts from tart cherries approached $US 58 million during 2003 (MASS, 2004). In addition, it is estimated that a majority of the processing capacity is also in Michigan. Using an output multiplier of 1.87 annual contribution to the state economy would approach $US 108 million.[2]

In this study, trade of frozen tart cherries (FTC) among the seventeen biggest country traders of this product is evaluated using a GM. Frozen tart cherries have been chosen as an empirical case because it is a product that clearly exemplifies the kind of subsector addressed by this study.

The motivation for selecting FTC was based on changes that developed in this subsector after a severe shortage in U.S. production during 2002.[3] This production shortage caused international players, such as Poland (the world's largest exporter) to move quickly to fill

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[1] The work done by Koo and Karemera (1991) is an exception; their work is discussed later.
[2] Doherty and McKissick (2000)
[3] In 2002 tart cherries yield in Michigan were 10 percent of the average yield from 2000 to 2004, excluding 2002 (NASS 2004).

the void and gain access to new markets. So, after 2001, the vulnerability of the sector and close connection to international was more evident. This is a case that exemplifies the reality of many agri-food subsectors, mostly small and medium enterprises (SME) based, that are still thinking locally without acknowledging the opportunities and threats that the new international scenario entails.

This study also has important implications for SMEs. In 2001, between one-quarter and two-fifths of worldwide manufactured exports were goods from SME (OEDC, 2002). In the United States (U.S.), 97 percent of exporters are classified as SME, and two-thirds of all companies that exported in 1999 were firms with fewer than 20 employees. SME exports represented one-third of U.S. exports in 1999 and both, the number of SME exporters and export volume from SME, show an increasing trend (U.S. Small Business Administration, 1999). In the U.S., for example, 56 percent of firms in the manufacturing industry of frozen fruit, juice, and vegetable manufacturing have 100 or less employees (U.S. Census Bureau, 2004a) and 50 percent of fruit and vegetable canners have less than 20 employees (U.S. Census Bureau, 2004b). Thus, an empirical tool to analyze trade determinants and trends of a specific commodity could be used by researchers to address issues important to SMEs.

1.2 Objectives

The general objective of this study is to identify trade flow determinants for a specific agri-food commodity (frozen tart cherries) at an 8-10 digit SITC using a gravity model. This study presents three more specific objectives, the first two are focused on relating the statistical characteristic of trade data for a specific agri-food subsector to the theoretical construction of a GM, and the third one is centered on an empirical case.

1. Determine adequate basic independent variables and an appropriate specification of the time-invariant variables in a gravity model for a disaggregated agri-food product.

2. Determine minimum data requirements of the specific product to be analyzed using a gravity model.

3. Estimate the determinants of international trade in frozen tart cherries and evaluate the trade potential among the largest exporters and importers of this product.

1.3 Procedures

The primary objective of this study is to identify the trade flow patterns of frozen tart cherries among the world's largest trading countries using a GM. This model is seen as an empirical tool to provide information about the determinants of international trade flows for specific agri-food goods and specifically FTC. The selection of a GM is based on its success in other empirical studies, although criticisms regarding weak linkages to a theoretical basis are acknowledged. In recent literature the theoretical foundation of the GM has been addressed, and focus has turned towards econometric specification of the model, albeit at an aggregate level. Here efforts are concentrated on analyzing relevant theoretical studies to reconcile trade of a disaggregated product with constructs of the GM.[4]

[4] The most relevant studies in this field are presented in a special section in chapter II.

Once the model is specified, attention will turn to the data. Koo and Karemera (1991) argue that the use of panel data is desirable in international trade analyses, particularly if there is high volatility in trade flows, which often is the case for agri-food products. A particular year may not provide accurate information to evaluate trade flows of a commodity with cross-sectional data only. The availability of a panel data set is not a constraint. Data used in this empirical analysis is based mainly on the EUROSTAT data base; it covers exports and imports of FTC among 17 selected countries from 1993 to 2003.

After a descriptive analysis of the data, two statistical issues, common to many agri-food products, must be addressed. The first issue is the reduced number of countries engaged in the trade of frozen tart cherries. The 17 largest exporters and importers of frozen tart cherries account for more than 85 percent of world trade. Given the limited number of countries, a random selection is illogical. Therefore sample is predetermined and the 17 countries will be included in the analysis. Such a constraint on the number of countries is likely to be more acute when the product analyzed is mainly produced by SME. For instance, according to the U.S. Small Business Administration (1999) 63 percent of the SMEs export to just one country. With a limited sample, time-invariant factors that affect trade between two countries (distance, cultural similarities, border effect, etc.) cannot be considered random and it is important to determine the proper way to include these effects in the analysis. The fixed effects specification of a GM, particularly evaluating it against random effects, has been studied to some extent.[5] Nonetheless, it is still not clear how to manage the fixed effects in order to account for all the factors that may determine trade among countries that are time invariant.

A second statistical issue is the large number of observations where the value of trade between two countries is zero. This issue is especially important for a disaggregate commodity like FTC. For example in 2004, even in a broad category such as fruit juices and vegetable juices (SITC - 059), the U.S. reported zero export values for almost 20 percent of the trading countries and zero import values for more than 30 percent of the trading countries. As food sectors are defined more specifically the number of zero observations is expected to increase.

A review of previous literature shows that some authors have dealt with a subset of these statistical issues (limited sample, censored dependent variable and panel data) in their studies, with differing degrees of depth, but none have incorporated all three, particularly not in the context of a specific product. Table 1 summarizes some approaches of researchers that have touched this topic. Specific contributions of these authors are discussed in greater detail in chapter II.

[5] See Mátyás (1997), Egger (2000) and Martinez-Zarzoso & Nowak-Lehmann (2003)

Table 1. Selected authors and their approach to the GM considering censored dependent variable, unobserved and time invariant variables and panel data.

Author	Panel Data	Unobserved variables [a]	Limited dependent variable	Time-invariant variables [a]
Koo & Karamera (1991)	√	√		√
Mátyás (1997)	√	√		
Soloaga and Winters (1999)			√	
Egger (2000)	√	√		
McPherson (2000)	√	√	√	
Martinez-Zarzoso (2003)	√	√		√
Carrillo & Li (2002)	√		√	
Cheng & Wall (2004)	√	√		
This study	√	√	√	√

[a] These two characteristics are closely related to the limited number of countries included in the study.

A GM that has been modified to account for limited sample size, censored dependent variable, and panel data is estimated to evaluate the determinants of international trade in FTC and evaluate the trade potential among the largest exporters and importers of this product. The statistical program STATA (version 8) was used to estimate the model.

1.4 Implications

The results of this study will address shortcomings of empirical tools available to analyze trade flow patterns of specific agri-foods and specifically of FTC. Such an analysis can generate insights for policy-makers who address particular agricultural subsectors impacted through strong linkages with international markets. This study will also be relevant for agri-food industries that are in the process of expanding their focus to include global competition. In addition, the procedures and techniques proposed in this study may be the base for future studies, particularly now that researchers have started to focus attention on the econometric issues of GM. The empirical results of this study address just the FTC subsector, nevertheless, the methodology presented can be widely used with other specific products.

CHAPTER II

2. Literature review

2.1 Gravity Model and International Trade

This section introduces the gravity model and discusses linkages between international trade theory and the gravity model.

2.1.1 Gravity Model

Newtonian Physics were first incorporated into human behavior studies by H. Carey in the 1860s. Since then, the "gravity equation" has been adopted for use in several social science fields including labor migration, commuting, consumer services, medical services and international trade.

Gravity models were first applied to international trade by Tinbergen (1962) and Pöyhönen (1963). Tinbergen developed the model to determine the normal or standard pattern of international trade that would prevail among 42 countries in the absence of trade barriers. He justified his model selection by claiming that this model, regardless of its simplicity, captures aspects relevant to the aim of his study. Besides the standard GM, Tinbergen also estimated other models including dummy variables for trade agreements and the presence of a common border among trading countries.

Pöyhönen (1963) presented, what he called, a tentative trade volume model to analyze trade volumes of ten European countries in a single year. A close connection between the "estimator function" and the "gravitational problem" was highlighted using the analogy that body mass is replaced by the square root of country GDP and transportation cost is replaced by the distance between countries.

After the seminal contributions of Tinbergen and Pöyhönen additional authors have increasingly used the model in an international trade context, adjusting the model to their specific needs. Linnemann (1966) included population as an additional measure of country size. Other authors used per capita income to express the level of economic development (Koo and Karamera,1991; Carrillo and Li, 2002). Models that include population are often referred to as augmented gravity models (Cheng and Wall, 2004). Other variables that are commonly used in a GM are dummy variables to control for cultural similarity among trade partners, such as language or historical relationships such as colonialism.

The basic form of the gravity equation is:

$$T_{ij} = A\frac{Y_i Y_j}{D_{ij}} \quad (1)$$

Where T_{ij} is the value of exports (imports) from country i to country j, A is a constant, Y is a measure of the size of the economy in each country (i and j), and D_{ij} is the distance between countries. In empirical estimation other variables can also be incorporated into this basic form such as: exchange rates, specialization indices, and dummy variables for the presence of a common border among the trading countries, a common language, or trade agreements. (Deardorff, 1995)

Prentice, et al (1998) derived the GM from a one-commodity, two-region theoretical trade model, which they represent in its reduced form as:

$$Q_E = Q_E(F, S_I, S_X) \qquad (2).$$

Assuming equilibrium between exporting and importing regions, the trade volume (Q_E) is determined by transportation costs (F) and supply and demand shifters in both importing and exporting regions (S_I, S_X). Given this specification, the authors conclude that "this is a gravity model in terms of explicitly relating trade flows to factors derived from interregional trade models and it is a reduced form of the interregional model" (Prentice, et al. 1998, p. 8).

Thus the authors express the reduced form of a gravity model as:

$$Q_{ijt} = Q\ (D_{ij}, S_{it}, S_{jt}) \quad (3)$$

where:

Q_{ijt} = Trade volume from region *i* to region *j* in year *t*

D_{ij} = Distance from region *i* to region *j* (Proxy for transportation cost, substituting for F from equation 3)

S_{it}, S_{jt} = Vectors of supply and demand shifters (income) in exporting region *i* and importing region *j*, respectively, at time *t*.

Using income (Y_{it} , Y_{jt}) as supply and demand shifters, expressing equation 3 in its multiplicative form, and taking natural logarithms this equation gives the expanded form of the gravity model:

$$\ln Q_{ijt} = \beta_0 + \beta_1 \ln D_{ijt} + \beta_2 \ln Y_{jt} + \beta_3 \ln Y_{it} + \varepsilon_{ijt} \quad (4)$$

2.1.2 International Trade Theory and Gravity Model

The GM has been praised as probably the most successful trade device of the last twenty five years (Anderson, 1979). More recently, Eichengreen and Irwin (1998, p.33) described the GM as the primary methodology ("workhorse") for empirical studies of regional integration. Despite success in the empirical analysis of trade patterns, the GM has been a target of critics for its lack of theoretical foundation. Several authors have worked on reconciling international trade theories with a gravity model specification. Here the most relevant theoretical supports developed for GM are presented.

Linnemann (1966), one of the first researchers trying to provide some theoretical foundation for the GM, justified its use by claiming that the GM is a reduced form of a four-equation partial equilibrium model of export supply and import demand, where prices are excluded. According to Linnemann, this initial attempt was found to be inconsistent with the multiplicative form of the partial equilibrium model.

The first formal theoretical explanations for GM were provided by Anderson (1979). He derived a GM using the properties of the expenditure function in countries where the preference structure is similar for traded goods. An important assumption was the hypothesis of homothetic preferences across regions, i.e. consumers with different income levels in different regions facing the same prices will demand goods in the same proportions. First he assumed Cobb-Douglas and then constant elasticity of substitution (CES) preferences. In both cases he also assumed that goods are differentiated by country of origin. Anderson concluded this study stating that the gravity equation can be derived from the properties of the expenditure system.

Bergstrand (1985) built on Linnemann's work and derived the GM from a general equilibrium framework. He demonstrated that a GM is a reduced form of a partial equilibrium sub-system of a general equilibrium trade model. A GM can be explicitly derived from a general equilibrium model of world trade. The reduced form of this system defines trade flow as a function of available resources, transport cost, and barriers to trade. The main assumptions underling his derivation are perfect substitutability, single factor of production in each country, and products that are differentiated by nations.

Deardorff (1995) established the link between the GM and the Heckscher-Ohlin Model (H-O) by deriving the GM from two separate cases of H-O. The first case assumes frictionless trade, where consumers and producers of homogeneous products are indifferent among trading partners. In the second case he considers countries that produce different goods and derived a GM with Cobb-Douglas preferences and then with CES preferences.

Evenett & Keller (1998) analyzed the accuracy of perfect specialization versions of the H-O model and the increasing returns to scale model and concluded that both supported the GM. In addition, they indicate these models are a limiting case of a model with imperfect specialization. More recently, Anderson and Wincoop (2001) developed a CES expenditure system to derive an operational gravity model. This derivation was made under the assumptions that all goods are differentiated by place of origin, that each region is specialized in the production of only one good, and that consumers have homothetic preferences.

These contributions have provided a solid theoretical foundation for the GM, refuting most of its earlier criticisms. In fact, Jeffrey Frankel (1998, p.2) pointed out that the gravity equation passed from a poverty of theoretical foundation to an overwhelming richness.

2.2 Gravity Model and Selected Empirical Applications

Use of the GM within international trade covers a wide range of subjects. This section presents empirical cases relevant to this study. The discussion is organized in two parts, estimation procedures and variable selection.

2.2.1 Gravity Model Estimation Procedures

Applying a GM, Rose (2002) estimated the effect on international trade of multilateral trade agreements - World Trade Organization (WTO), General Agreement on Trade and Tariffs (GATT) and General System of Preferences (GSP) - among a panel data set of 175 countries over fifty years. Besides the standard variables of a GM, common language, landlocked situation and historical colony links were also included as explanatory variables. The basic GM was estimated using ordinary least squares (OLS), computing standard errors that are robust to clustering by country-pairs. In order to control for global business cycles and other time factors, year-specific fixed effects were included. This setup of country-pair and time panel data was estimated using random effects (GLS) as well as fixed effects (OLS) estimators as robustness checks. Rose filtered his data in several ways; in one he included in the analysis non-members (both trading partners) and the case where just one of the countries is a GATT/WTO member. To estimate this particular case he used a maximum likelihood Tobit estimator.

Wall (2000) demonstrated that a gravity model allows for heterogeneity across countries, i.e. fixed effects, and provides unbiased estimates of the volume of trade. He performed his analysis using data from trade among Canadian provinces and U.S. individual states. The dependent variable, $ln(1+x_{ijt})$, allowed inclusion of observations where measured trade was zero, but the empirical estimation did not account for the limited dependent variable.[6] The model in this study was estimated by general least squares (GLS). Since the model includes fixed effects, time invariant variables can't be estimated directly. However, a second stage OLS regression on the fixed effects on the time-invariant variables was applied to estimate the impact of time-invariant variables.

Carrillo and Li (2002) applied the GM to examine the effects of the Andean Community and Mercosur on both intra-regional and intra-industrial trade in the period 1980-1997. They solved their model using random-effects Tobit left-censoring estimation to account for country-pairs with zero trade. To account for intra-industrial movement, data was

[6]In an earlier study, McCalum (1995) analyzed the border effect using trade data from U.S. and Canada where all observations with a zero dependent variable were omitted.

disaggregated at the three-digit SITC, covering eleven countries. The study does not present a discussion about the author's choice of random effects over fixed effects. Results indicate that Andean Community preferential trade agreements had a significant effect on capital intensive and differentiated goods, whereas Mercosur preferential trade agreements had a positive effect on capital intensive goods only.

2.2.2 Variable selection

While the basic variables of gravity model are well known (i.e. purchasing capacity, output capacity, and transport cost) there is still some discussion on the best proxy variables to capture those effects. In the following section, some relevant studies that addressed this issue are presented.

Koo and Karamera (1991) performed a non-nested JA[7] test where GDP expressed in current U.S. dollars was evaluated against GDP-PPP[8] as an alternative variable to control for income effects in the importer country, and GDP, also expressed in current dollars, was evaluated against agricultural GDP as a proxy variable to capture the output capacity of the exporter country. In both cases, the second alternative was preferred. Nine wheat exporting countries and 34 importing countries between 1981 and 1987 were included in the analysis. Observations where the dependent variable was zero or small were excluded from the analysis. After performing a Hausmann test, the authors decided to use fixed effects. They presented two model specifications, first a covariance model estimated

[7] The JA test is a hypothesis testing procedure.
[8] GDP expressed in purchasing power parity.

with OLS using variables expressed in deviation form, and second an error component model following the Fuller and Battese (1974) procedure.

Prentice et al (1998) specified a GM for interregional trade of Canadian pork exports to the United States to identify potential markets for each of the five major Canadian exporting provinces. Dummy variables are included to distinguish high-volume from low-volume market regions. Although this is an implicit recognition of the censored nature of the dependent variable, the estimation procedure does not explicitly consider this issue. Instead the models (one for each of the five provinces) are estimated using a pooling technique that combines the cross-section and time-series data.

Regional trade analysis is another trade field where the use of GM is common. Paas (2003) explored international trade flows of countries involved in EU eastward enlargement processes. Included is a discussion about the most accurate selection of GDP as independent variable, i.e. GDP expressed in current currency or expressed in terms of purchasing parity power (GDP-PPP) which captures the income effect. Results indicate that statistical estimations are the best in equations using GDP-PPP. The model (cross sectional) was estimated by OLS using white heteroskedasticity-consistent covariance estimators. Previous results of modeling bilateral trade flows between the countries of the Baltic Sea Region using 1998 data show that the statistical estimations have a better fit in the equations with GDP-PPP (Pass, 2003).

Growing empirical literature finds that historical linkages are important determinants of international trade flows (Frankel, Stein and Wei, 1995; Frankel, 1997; Eichengreen and Inrwin, 1998). Lagged bilateral trade flows are significant in determining current trade in a large cross-section of countries, after controlling for income and distance. This indicates that past trade linkages adjust slowly to new conditions.

2.3 Gravity Model and Econometric Tools

In the following section, the most relevant econometric topics for a specific good are discussed, emphasizing censored panel data, fixed effects vs. random effects, and discussing the implications of these effects on a Tobit model.

2.3.1 Censored Panel Data

Wooldridge (2002) defines panel data as a set of data formed by repeated observation of the same cross-sectional units over time. Panel data generally require extra time and cost, and also creates some econometric challenges. Nerlove (2002) indicates that the problem of latent individual heterogeneity is the central problem in panel data econometrics. Kennedy (2003) highlights the following advantages of panel data:

- Allows control of heterogeneity of the cross-sectional units. It is to be expected that each cross-sectional unit has some intrinsic and immeasurable characteristics distinguishing it from others.
- The combination of cross-sectional and time elements generates more variability, and at the same time reduces multicollinearity problems.

- Panel data can be used to identify the effect of time-varying variables (e.g. technology) and cross-sectional variables (e.g. economies of scale) simultaneously.
- Panel data allow better analysis of dynamic adjustments.

Some dependent variables are limited in their range. The econometric analysis of data sets with limited dependent variable requires special treatment. Maddala (1983) distinguishes two types of limited dependent variables, truncated and censored. A truncated regression is one where there is not any observation for either the dependent or the independent variables when the value of the dependent variable is above (or below) a certain threshold. (e.g. negative-income tax experiment).

In a censored regression the data of explanatory variables exists for all observations, but there is group of observations where the value of the dependent variable is missing (non-observable). Examples of this type of sample are reservation wage or demand for durable goods. It is not difficult to imagine an economic agent maximizing utility at a corner solution. (i.e. $y = 0$). Wooldridge (2002) calls these kinds of models “corner solution models”.

Estimation of censored regression using OLS will generate biased and inconsistent parameter estimates. A preferred estimation procedure is maximum-likelihood (Pindyck and Rubinfeld, 1998) where the likelihood estimation is the product of expressions for the probability of obtaining each observation. A common model to estimate censored regression is the Tobit model, named after James Tobin, who was the first to analyze issues raised by censored data. The Tobit model is defined as follows:

$$y_i = \beta \mathbf{x}_i + \varepsilon_i \quad \text{if the dependent variable is} > 0 \qquad (5)$$

$$y_i = 0 \quad \text{otherwise}$$

where y is the censored dependent variable, $\mathbf{x}$ is a vector of explanatory variables, β is a set of parameter to estimate, and ε is the error term. In the case of a Tobit model, maximum likelihood will be as defined above for dependent variable observations greater than zero. The likelihood for observations with censored dependent variables equals the probability of getting an observation below a threshold (Kennedy, 2003).

Censored panel data include a set of observations for the same cross-sectional units over a period of time in which the dependent variable of a subset is censored. Wooldridge (2002) presents the basic form of censored panel data as:

$$y_{it} = \max(0\,, \beta \mathbf{x}_{it} + \varepsilon_{it}), \ \ t = 1,2,\ldots\ T \qquad (6)$$

$$\varepsilon_{it} \mid \mathbf{x}_{it} \sim \text{Normal } (0, \sigma^2)$$

where the variables and parameters are defined as in equation 5. In this case the cross-sectional unit i is observed over time t. Since the model does not maintain strict exogeneity of $\mathbf{x}_{it}$, lagged variables can be incorporated in the model. In addition the error terms, ε_{it} are allowed to be serially dependent. In practical terms, this means that $\mathbf{x}_{it}$ can contain any conditional variables such as interaction of time dummies with time-constant or time-varying variables. Both characteristics are relevant to this study. Maximum likelihood can be used to estimate the model depicted in equation 6; however, to control for serial correlation across time a robust variance matrix is needed.

2.3.2 Fixed vs. Random Effects

An inherent issue raised by the use of panel data is the decision of how to treat unobservable variables, i.e. fixed or random effects approach. Wooldridge (2002) presents the following basic unobserved effects model

$$y_{it} = \beta \mathbf{x}_{it} + c_i + \varepsilon_{it} \quad t = 1,2,\ldots T \qquad (7)$$

where $\mathbf{x}_{it}$ is $1\text{x } K$ and contains explanatory variables that for propose of this analysis can be classified in three categories: time-invariant variables (e.g. distance between countries), variables that change over time but not among cross-section units (e.g. international exchange rates), and variables that change over time as well as from one cross-sectional unit to another. (e.g. GDP, crop yield). The variable c_i, captures the unobservable effects; in the case of the gravity model cross-sectional heterogeneity such as variation among pairs of trading countries (e.g. UK – U.S. and Canada-Germany). Finally, ε_{it}, is the idiosyncratic error.

An important consideration in this unobservable effects model is whether to treat c_i, as a random effect or as a fixed effect. Random effects implies that c_i is considered a random variable and it becomes part of the error term. The error term is a composite formed by two parts: one, in the case of a gravity model, is the "random intercept" of a county-pair, and the second is the normal error term. Kennedy (2003) shows that in a random effects model not all of the off-diagonal elements of the variance-covariance matrix of this composite error term are zero (i.e. non-spherical), which could indicate a certain degree of autocorrelation.

On the other hand, considering c_i as fixed implies that it is a parameter that has to be estimated for each cross-sectional unit, generally by adding a series of dummy variables. Fixed effects estimation has two major drawbacks: a) the use of a dummy variable for each cross-sectional unit generates a loss in degrees of freedom; b) time-invariant variables are not identified and must be discarded from the equation. Wooldridge (2002) states that the key issue that determines if c_i should be considered random or fixed is whether or not it is correlated with the observed variables (i.e. $\mathbf{x}_{it}$). If c_i is uncorrelated, random effects estimation is more appropriate.

McPherson (2000), using a GM, argued for random effects assuming that the differences between cross-sectional units of his study were randomly distributed. These cross-section units, the pair of potential trading partners, were postulated to be different in terms of economic, social, political and geographic conditions. In his model he used a random-effects Tobit (weighted maximum likelihood) estimation procedure. Later the same author (2001) estimated a gravity model to test Linder's hypothesis in developing countries by using fixed effects. In this case he argues that fixed effects can be used if the sample represents a relatively large proportion of the population and if unobservable factors that differentiate each country-pair are best characterized as parametric shifts of the regression function.

2.3.3 Panel Data, Tobit Model and Fixed Effects

Fixed effects in non-linear models, such as Tobit, present difficult statistical problems, particularly if the period of time covered by the sample is small. One of the most critical issues with fixed effects and a limited dependent variable is the "incidental parameters" problem. Heckman and Macurdy (1980) argue that if the number of periods observed for each cross-sectional unit is small (eight in their case) it is not possible to consistently estimate fixed effects. In these cases the structural parameters are themselves a function of the fixed effects, thus inconsistency in the fixed effects is transmitted to the estimated structural parameters. Maddala (1983) expands Heckman and Macurdy's arguments using the following non-linear model (Tobit):

$$y_{it}^{*} = \alpha_i + \beta \mathbf{x}_{it} + \varepsilon_{it} \qquad \varepsilon_{it} \sim IN(0, \sigma) \tag{8a}$$

$$y_{it} = y_{it}^{*} \text{ if } y_{it}^{*} > 0$$

$$y_{it} = 0 \text{ otherwise}$$

In this case it is not possible to devise estimators of β and σ that are not independent of α (fixed effects), particularly if T (number of observations per i) is small. Heckman and Macurdy concluded that the inconsistency of the estimates might not be a serious problem if there are no lagged dependent variables. This model was estimated for a Probit model. Results indicate a similar procedure could be applied to a Tobit model, which is expected to have even better behavior, since it combines the linear regression model with the Probit model.

Maddala presents an alternative to the "incidental parameter" problem originally presented by Heckman and Macurdy (1980), he derives model estimators by iterative methods.

Let

$$d_{it} = 1 \text{ if } y_{it}^{*} > 0 \text{ ; } d_{it} = 0 \text{ otherwise.}$$

Then the likelihood function is defined:

$$LogL = \sum_{i,t}(1 - d_{it})\log\Phi\left(\frac{-\alpha - \beta x_{it}}{\sigma}\right) + \sum_{i,t} d_{it}\left\{-\frac{1}{2}\log\sigma^2 - \frac{1}{2\sigma^2}(y_{it} - \alpha_i - \beta x_{it})^2\right\}. \quad (8b)$$

In an empirical application Hirschberg et al (1994) applies a "weighted cross-section/time-series fixed effects Tobit" procedure to estimate intra-industry trade. The weights are given by the number of items included in the ISTC category. Unfortunately, the author doesn't present any further reference about this method and its characteristics other than the program used for its estimation (LIFEREG in the SAS system).

Greene (2004b) addresses the same issue, i.e. the "incidental parameters" problem, indicating that while the maximum likelihood estimator (MLE) in a non-linear panel data model with fixed effects is understood to be biased and inconsistent (particularly when T is small), there is little empirical and theoretical evidence to support this conclusion. He uses a Monte Carlo method to examine the behavior of the MLE of the fixed effects Tobit model concluding that the estimators for this model are unaffected by the "incidental parameters" problem. However, Greene reports that the finite sample bias appears in the disturbance variance rather than in the slopes, and this bias would be transmitted to estimates of marginal effects. This new issue in the estimation seems to become less severe if T is five or more and if the degree of censoring in the data is around 50 percent. A point to take into account is that standard errors are underestimated by the MLE with fixed effects. This could make some results appear significant when they are really not.

CHAPTER III

3. Model Derivation and Empirical Analysis

This chapter is divided into three sections. The first section presents an overview of the FTC sector, highlighting the fact that this sector is a case that exemplifies other agri-food sectors that have the same characteristics (i.e. a relatively small industry with a high impact on local economies, dominated by SME). The second part develops the specification for a GM to estimate trade flows for a specific commodity. The third section of the chapter introduces the variable selection criteria and data used to estimate a GM for FTC.

3.1 The Frozen Tart Cherry Sector

FTC are an intermediate product destined for use in the ingredient, bakery and desert industries. Initial processing is done mostly by firms located close to growing areas due to post-harvest requirements of the fruit. Once the fruit is harvested it has to be processed, or at least cooled, within the next 24 hours. Primary growing countries of tart cherries are Russia, Poland, Turkey, U.S., Germany, Serbia and Montenegro, Iran and Hungary (Figure 1). The average production of these eight countries represents 90 percent of world output.

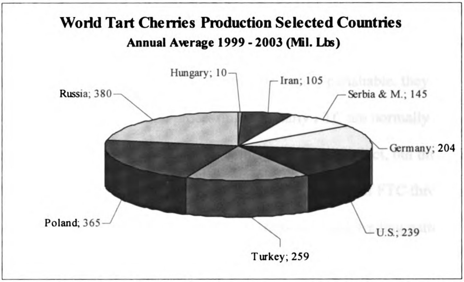

Figure 1. World Tart Cherry Production, annual average of selected countries.
Source: FAO, DataStat

FTC trade has grown steadily the last decade. In 1993 total trade value of FTC was $US 20 million worldwide. By 2003 trade value approached $US 80 million. Table 2 shows the average annual exports of a country to their trade partners for selected countries between 1993 and 2003 (for the complete table see Annex 1). The total at the bottom of each column represents average total value of FTC exported by a particular country. The totals at the end of each row represent average total imports by a particular country. So, for example, on average between 1993 and 2003 Poland exported $99,221,000 of FTC. Over the same period, Germany imported on average $90,560,000 of FTC.

Poland is by far the largest exporter of FTC with a 55 percent share of the total value of FTC traded. Germany is the main consumer absorbing more than 50 percent of the FTC imports. Clearly transshipment of product occurs; Netherlands and Belgium have substantial values for both imports and exports yet neither is a significant raw tart cherry producer. Their role as producers of FTC is based on purchases of either raw tart cherries or an intermediate product from countries such as Poland, Germany, Turkey or Hungary or transshipment of FTC. Since raw tart cherries are highly perishable, they are rarely moved long distances before initial processing. Similarly FTC are normally considered a product of initial processing (the exception would be chilled product, but this still maintains a relatively short shelf-life). Therefore, transshipment of FTC through Belgium and Netherlands almost certainly occurs. This is consistent with trading patterns of those countries with regard to other agricultural products. Poland is the main supplier of these two countries, followed by Germany.

Table 2. Average yearly value of frozen tart cherry exports of selected countries, 1993 – 2003.

	Value of FTC Exports (000 $US)									Total Imports
	BEL	CAN	GER	HUN	NED	POL	TUR	UK	U.S.	
AUT	4	185	-	5	8	40	1	-	211	669
AUS	94	-	1,540	177	316	921	64	10	49	3,202
BEL	-	52	1,607	667	1,420	4,456	408	142	1,987	12,234
CAN	132	-	21	3	38	228	22	-	5,472	5,928
DEN	2,147	-	386	-	278	1,808	69	30	31	4,771
FRA	5,995	-	3,495	32	2,163	5,380	292	165	863	18,750
GER	57	142	-	3,037	7,598	71,100	3,497	336	1,863	90,560
GRE	11	-	123	-	4	288	208	19	-	653
HUN	156	23	14	-	8	113	12	-	-	332
ITA	-	15	2,613	14	546	899	457	-	119	5,344
JAP	-	210	-	2	7	-	-	-	1,109	1,566
MEX	1,192	-	-	-	-	-	-	-	146	1,343
NED	27	34	4,793	410	-	7,908	339	64	1,449	15,491
POL	-	18	189	39	21	-	-	13	-	304
TUR	622	-	18	1	11	-	-	-	-	653
UK	70	202	911	-	1,954	3,437	1,980	-	203	11,456
US	185	3,168	8	20	130	2,642	39	-	-	6,215
Total Exports	10,692	4,049	15,717	4,407	14,500	99,221	7,389	780	13,502	179,472

Source: Data Service and Information (DSI-Eurostat)

The U.S. is a net exporter of FTC; Canada, Japan, Germany and Netherlands have been the primary destinations. In the last five years U.S. imports have increase considerably. In 1999 U.S. imported less than one million metric tons of FTC while that figure for 2003 was over 5 million tons. Primary exporters to the U.S. are Poland and Canada. Since 2002 Poland has become the most important FTC supplier of U.S.; in 2003 Poland supplied more than 70 percent of U.S. FTC imports. The U.S. industry is concentrated in Michigan, whose processing capacity represents 70 percent of the domestic total. There are 114 tart cherry processing firms in Michigan which are supplied by around 600 farmers (Cherry Marketing Institute, 2003).

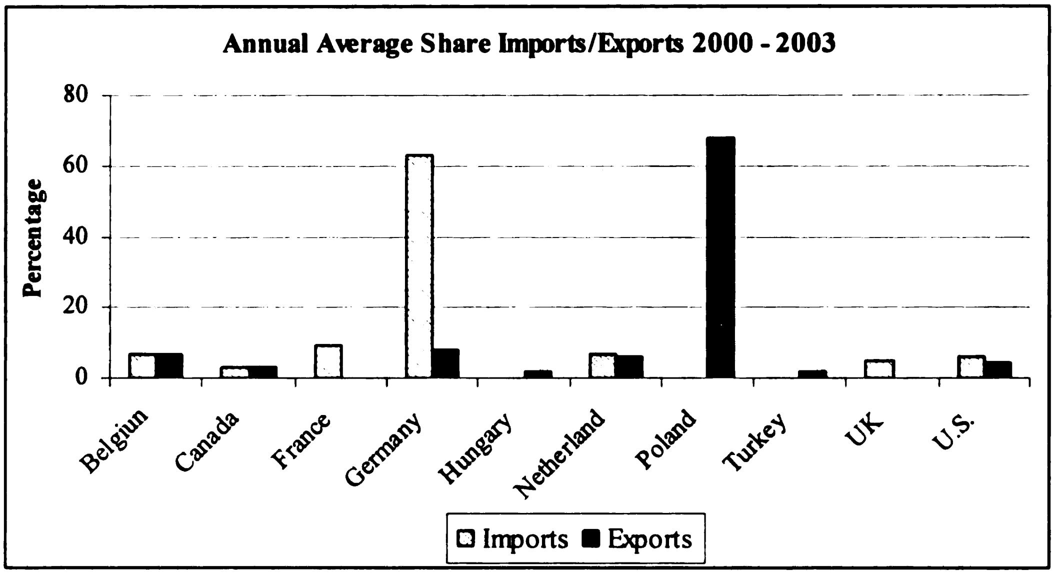

Figure 2. Import and Export Shares, annual average from 2000 to 2003 of selected countries.
Source: Data Service and Information (DSI-Eurostat)

In contrast, Poland has based its tart cherry industry on more than 133,000 farmers, from which 125,000 have less than 2.5 acres. The fruit and vegetable processing industry in Poland is an important sector of the economy which also remains primarily in the hands of small enterprises. In 2000 the entire food processing industry employed 457,000 people and there were 34,519 firms (OECD, 2002). Halicka (2001) estimated that 63 percent of the fruit and vegetable processing industry in Poland has fewer than six employees.

The volume of imports and exports of FTC at a worldwide level are rather modest compared to total world agriculture trade figures. A large part of the FTC production industry is in the hands of SME. This industry, which can be considered small, has an important role at the local level, not just because it generates employment, but also because it generates economic movement down-stream (farmers and input suppliers) and up-stream (other food processing industries). This industry exemplifies several other agri-food industries in terms of its structure and other characteristics such as the reduced number of importing countries, the relatively low consistency of trade flow among trade partners, and the limited numbers of trade players worldwide. These characteristics of the industry are translated into trade data that has: 1) a censored dependent variable and 2) the need for the use of fixed effects specification. These statistical issues require special consideration in specifying a GM for a specific agri-food commodity.

3.2 Development of a Commodity Specific Gravity Model

The basic and most often applied form of a gravity model is represented by the log-linear equation:

$$\ln y_{ij} = \beta_0 + \beta_1 \ln x_i + \beta_2 \ln x_j + \beta_3 \ln d_{ij} + \sum_h \gamma_h w_{ijh} + \varepsilon_{ij} \qquad (9)$$

where:

y_{ij} = Trade volume from region i to region j

$x_{i,j}$ = GDP in countries i and j respectively

d_{ij} = Distance from country i to country j

w_{ijh} = Dummy variables

ε_{ij} = Error term

GDP measures the size of the economy in the importing and exporting countries, and distance serves as a proxy for transportation cost. Dummy variables most frequently included in the model are sharing of common border and the presence of special trade agreements. This basic model is applied to a single year, therefore, the effects of changes over time are not included. Parameters of equation 9 are interpreted as a composite effect of within and between-country effects (Egger, 2000).

Time variability can be incorporated in a GM by re-writing equation 9 as follows:

$$\ln y_{ijt} = \beta_0 + \beta_1 \ln x_{it} + \beta_2 \ln x_{jt} + \beta_3 \ln d_{ij} + \sum_h \gamma_h w_{ijth} + \sum_k \lambda_{tk} t_{tk} + c_{ij} + \varepsilon_{ijt} \qquad (10)$$

where:

t = Dummy variables for each period of time

c = Unobservable variable

and the rest of the variables are defined as above.

Equation 10 is able to capture the relationship between relevant variables over time, as well as to identify effects of the overall business cycle through proper selection of dummy variables (t) for annual variations in trade flow. Estimated panel data coefficients from Equation 10 can be interpreted as the elasticity of the influence of an independent variable on the dependent variable. In the case of a GM that means that β_2 would be the income elasticity of the country j (Egger, 2000).

The unobserved variable, c, controls for time-invariant effects between countries. As noted in Chapter 2, in a GM context there is little research about whether fixed or random effects should be used on trade between each pair of countries, namely how to treat c. Selection will depend on sample characteristics and/or econometric tests. Analysis of sample characteristics, an intuitive approach, is based on examination of the latent variables that are likely to be behind country-pair effects. Such variables may include tariff and non-tariff policies, geographic and historical determinants. As most of these variables can't be considered random but deterministic, an intuitive selection would be to use fixed effects. Moreover, this selection gains strength if the sample selection is based on a limited group of countries (non-random selection), either from a particular geographic region, from a trade agreement block, or traders of a specific commodity. Egger (2000) confirmed this intuition based on a Hausman X^2 – test. He showed that fixed effects are preferred over random effects in a study of total trade relationships among OECD countries over a period of 12 years.

Empirical specification of fixed effects in a GM is another issue where there is not a clear consensus. McPherson, et al. (2000) imposed a fixed effect only for the exporting country. Mátyás (1998) and Egger (2000) estimated a three-way model, which sets fixed effects for the exporter, importer and time dimensions. Rose (2002) included a time fixed effect. To be consistent with the discussion above fixed effects should be set based on the cross-sectional units, i.e. for each country-pair, since the unobservable variables are likely to be specific for each pair of countries. Given this specification, the number of parameters to be estimated ($i \times j$-1) increases rapidly for each country added to the sample which could lead to over-parameterization, making estimation of the model infeasible. A method to reduce the number of parameters in the GM case is to allow the unobservable variables to have a similar effect across each two-country pair, regardless of which is the importer or the exporter. This assumption reduces the number of fixed effect parameters by half.

An appropriate specification of a GM in a panel data context using fixed effects can be rewritten as:

$$\ln y_{ijt} = \beta_0 + \beta_1 \ln x_{it} + \beta_2 \ln x_{jt} + \beta_3 \ln d_{ij} + \sum_h \gamma_h w_{ijth} + \sum_k \lambda_{tk} t_{tk} + \sum_l \alpha_{ijl} f_{ijl} + \varepsilon_{ijt} \quad (11)$$

where:

f_{ij} = the fixed effect for each country-pair either for i as an importer or exporter

α_{ij} = the fixed effect parameters to be estimated

and other variables are defined as above.

A common occurrence in trade analysis of a specific commodity within a group of countries over a period of time is the presence of non-trade observations (zero exports or imports). This means that y_{ijt} in equation 11 could be zero for some observations. Even at the 3-digit SITC classification level (i.e.: more aggregated) it is likely to find between 20 and 30 percent of the observations reported as zero.

An empirical specification for modeling data sets where the proportion of zeroes in the dependent variable is significant is a censored regression model. The presence of zeroes in the dependent variable can be seen as a corner solution of a maximization problem. In the case of trade, that is to say that country *i* decided, as its optimal choice, to maximize profits by exporting zero to country *j* in period *t*. The Tobit model is an appropriate specification and equation 11 would be re-written as:

$$\ln y_{ijt} = \max\left(0, \beta_0 + \ln \mathbf{x}_{ijt}\boldsymbol{\beta} + \sum_h \gamma_h w_{ijth} + \sum_k \lambda_{tk} t_{tk} + \sum_l \alpha_{ijl} f_{ijl} + \varepsilon_{ijt}\right) \quad t = 1,2,\ldots \mathrm{T}$$

$$\varepsilon_{it} \mid \mathbf{x}_{ijt}, w_{ijth}, f_{ij} \sim \text{Normal}\ (0, \sigma^2) \tag{12}$$

where variables are defined as above except for $\mathbf{x}_{ijt}$ which is now a vector of GDP and distance. This model is estimated by maximum likelihood (MLE). As was noted in Chapter II some authors have suggested that MLE in non-linear models using fixed effect is biased and inconsistent, particular when T is small and fixed. However, Greene (2004b) found that for the specific case of Tobit models MLE may be an adequate estimator if certain conditions are satisfied. Greene established these conditions using Monte Carlo simulation, where he analyzed different levels or forms for critical characteristics of the model (period length, degree of censoring and dependent variable distribution). These conditions are discussed below in a GM context.

The period length (T) does not affect bias of the estimates (β, α and γ); however, it has an important effect on the standard deviation which is biased downward (24 percent for T =

4). This bias diminishes as T increases; for instance if T = 8 the standard deviation bias will be approximately 8 percent (N = 1000).[9] Degree of censoring will also affect the bias of the estimates. Between 40 and 50 percent censoring, assuming T = 5, will generate unbiased estimates. In general at least 40 percent of y_{ij} have to be zero, which for the case of specific commodity analysis is not a critical constraint (Greene, 2004b).

Distribution of the dependent variable (normal, chi-squared or AR(1)) does not affect bias of the parameters. Again, distribution impacts bias in the standard deviation; however, this effect is not significant, particularly if T > 5 and the degree of censoring is over 40 percent. The variables included in a basic GM are likely to have one of the three distributions studied by Greene (GPD, AR(1); Normal).

Thus, a GM using panel data for a specific commodity can be estimated by MLE, with some confidence if data covers a period of time longer than five years, more than ten countries are included in the analysis, the proportion of zeros in the dependent variable is greater than 40 percent, and the explanatory variables included in the model follow a Normal, Chi-squared or AR(1) distribution.

3.3 Empirical Methods for Frozen Tart Cherry Trade Analysis

Prior to explaining the empirical methods used in this study, a brief discussion of the data utilized follows showing basic statistics and trends of the values of the independent variables.

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[9] In the Monte Carlo simulation used by Greene, he set N=1000. So, N has to be at least equal to 1000 to have consistent results.

3.3.1 Data

The data set for this analysis has 2992 observations [$i \times (i\text{-}1) \times T$], over a period of 11 years (1993 – 2003). It is unbalanced panel data, which is common in a GM setup, since no country trades with itself. Almost 63 percent of the observations are zero (non-trade among the countries). Thus the data set fits into the minimum requirements to estimate a GM model with fixed effects. The countries included in the analysis are Australia, Austria, Belgium, Canada, Denmark, France, Germany, Greece, Hungary, Italy, Netherlands, Japan, Mexico, Poland, Turkey, United Kingdom and United States. These seventeen countries are the largest exporters and/or importers of FTC. The volume traded among these countries in 2003 accounted for more than 85 percent of world trade volume.

The specific trade name of the item analyzed in this study is "Sour Cherries *Prunus cerasus*, Whether or not Boiled or Steamed, Frozen, not Containing Sugar or Other Sweetening Matter" The value of FTC trade (dependent variable) is measured in thousands of current U.S. dollars. This information was gathered from different sources. The most important source was Data Service and Information (DSI-Eurostat) for the European countries and their trade partners. It accounts for almost 80 percent of the observations. Other data sources are STAT-USA (U.S. and trade partners), Canadian Statistic Service (Canada and trade partners), and OECD- International Trade Data Base (Australia, Hungary, Poland, Mexico and Turkey).

With one exception, data was available at a ten-digit Standard International Trade Classification (SITC) level of disaggregation. The data from OECD was at a different level of aggregation (six-digit SITC), so it was necessary to estimate the portion of this item that corresponded to FTC. This estimation was based on the data reported from other sources. Less than two percent of the observations were estimated using this procedure, since most of the observations were zero. In the cases where the data reported from a country did not coincide with that reported by the trading partner, a simple average was taken from the two observations.

Explanatory variables included in the model are current gross domestic product per capita at purchasing power parity (GDP-PPP),[10] agricultural value-added,[11] population, and lagged total yearly export/import. Data for the two first variables were obtained from the World Bank Development Database. Distance, measured as kilometers between capitals cities, was obtained from the Great Circle Distances Between Capital Cities web page. Lagged yearly export/import data is the aggregation of total exports or imports of FTC in the previous year.

Table 3 shows values for the year 2003 of the three time-variant variables: total agriculture value-added, GDP-PPP and population. As an indicator of trends, the average rate of growth between 1993 and 2003 for each variable is also included in the table. The

[10] Purchasing power parity (PPP), an international dollar has the same purchasing power over GDP as a U.S. dollar has in the United States. For example, GDP per capita in China is about $US 1,500, while on a PPP basis, it is about $US 6,200.

[11] Agricultural value-added corresponds to the International Standard Industrial Classification (ISIC), divisions 1 to 5, and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. Value-added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. (World Bank, Development Indicators)

agricultural output of the U.S. is three-times larger than the second largest agricultural output from the selected countries. Belgium and Netherlands have a relatively small agricultural output, however they are important players in the FTC market. Japan, on the other hand, has the second largest agricultural value-added but its role in FTC markets is limited as buyer and it has a low share of the worldwide demand. The negative rate of growth in the agriculture sectors of Mexico, Poland and Turkey, can be explained in part by the dynamism of other economic sectors in those countries that compete for resources with the agricultural sector. As countries develop agriculture normally becomes a smaller part of the economy.

Table 3. Value of continuous independent variables for 2003 and average rate of growth between 1993 and 2003.

Countries	Agriculture value-added		GDP per capita PPP		Population	
	Current Million US$	Avg. rate of growth	International dollars	Avg. rate of growth	Thousands	Avg. rate of growth
AUT	12,076	0.5%	29,632	4.3%	19,881	1.2%
AUS	5,327	0.7%	30,094	3.6%	8,090	0.2%
BEL	3,565	-1.1%	28,335	3.5%	10,376	0.3%
CAN	15,496	0.4%	30,677	4.1%	31,630	0.9%
DEN	3,875	-1.7%	31,465	3.7%	5,387	0.4%
FRA	42,635	1.0%	27,677	3.4%	59,762	0.4%
GER	24,707	0.1%	27,756	3.1%	82,541	0.2%
GRE	10,442	1.5%	19,954	4.8%	11,033	0.5%
HUN	2,367	0.0%	14,584	5.4%	10,128	-0.2%
ITA	34,856	0.8%	27,119	3.3%	57,646	0.1%
JAP	46,053	-7.2%	27,967	2.7%	127,573	0.2%
MEX	22,981	-1.5%	9,168	2.7%	102,291	1.5%
NED	9,156	-2.0%	29,371	3.9%	16,222	0.6%
POL	5,280	-1.6%	11,379	6.0%	38,196	-0.1%
TUR	26,931	-3.6%	6,772	2.7%	70,712	1.7%
UK	15,487	-0.6%	27,147	4.1%	59,329	0.2%
US	158,947	3.1%	37,562	3.6%	290,810	1.1%

Source: World Bank Development Indicators

The difference in agricultural output between U.S. and the rest of the countries is less evident when it comes to GDP – PPP per capita. Net exporting countries such as Turkey, Poland and Hungary, have a GDP – PPP per capita below the average of the countries included in the analysis, but Poland and Hungary have the highest average rate of growth of GDP – PPP per capita. The values for this variable for FTC net importing countries (Germany, U.S, UK, Japan) are above the average, and have large rates of growth for this variable. The negative rate of population growth in Hungary and Poland could be attributed to the migration rates from those countries to Western Europe.
The relatively high and positive population rate of growth of Australia, Mexico and U.S. can be attributed to migration trends and/or high rate of births.

Distance (measured in kilometers between capitals) presents a large range of variation. The greatest distance was found between Australia and the United Kingdom (16,973 Km. or 27,309 miles). On the other hand, the distance between the capital of Belgium and Netherlands is just 173 Km. (278 miles). Annex 2 shows the distance between all 17 capitals. This table also presents information about the countries that share borders as well as those that have signed a free trade agreement.

3.3.2 Empirical Model

The value of trade is estimated using a Tobit model with fixed effects by MLE (based on equation 12) which takes the form:

$$\ln y_{ijt} = \max\left(0, \beta_0 + \ln \mathbf{x}_{ijt}\boldsymbol{\beta} + \mathbf{w}_{ijt}\boldsymbol{\gamma} + \mathbf{f}_{ij}\boldsymbol{\alpha} + \mathbf{t}_t\boldsymbol{\lambda} + \varepsilon_{ijt}\right)$$
$$t = 1,2,\ldots \mathrm{T};\ \ \varepsilon_{it} \mid \mathbf{x}_{ijt}, \mathbf{f}_{ij}, \mathbf{t}_t \sim \text{Normal}\ (0, \sigma^2) \tag{13}$$

where:

y_{ijt} = trade value expressed in current U.S. dollars from region i to region j in the period t expressed in current dollars.[12]

$\mathbf{x}_{ijt}$ is a vector that contains the following variables expressed in logarithms:

ag_{it} = agricultural value-added expressed in thousands of current $U.S. in exporting country i in period t

px_{it} = population expressed in thousands in exporting country i in the period t

$gp_{.jt}$ = per capita GDP at purchasing power parity expressed in thousands of international $U.S. of importing country j in period t

pm_{jt} = population in thousands in importing country j in period t

lx_{jt-1} = value of total FTC exports expressed in thousands of current $U.S. of country i in period t-1

lm_{it-1} = value of total FTC imports expressed in thousands of current $U.S. of country j in period t-1

$\mathbf{f}_{ij}$ = vector $(1\times (i \times j\text{-}1)/2)$ that contains a dummy variable for each pair of countries regardless of whether the country is importer or exporter. The number of variables contained in $\mathbf{f}_{ij}$ is136.

$\mathbf{t}_t$ = vector (1 x T) of dummy variables for each year, where 1993 is the base year.

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[12] A unit was added to y_{ijt} in order to be able to estimate the its logarithm when $y_{ijt} = 0$. This monotonic transformation does not affect the estimates results, but requires special consideration at the moment of estimating the expected value of y_i (Wooldridge, 2005).

The classic GM uses total GPD as a proxy for output capacity in the exporting country, which is appropriate for studies using aggregated total export data. In the case of a single commodity, total GDP would overestimate output capacity of the country for that particular commodity. A better proxy to capture the output capacity for a specific commodity is the portion of GDP for the sector that is related to the good under consideration. In the case of this study FTC is part of agricultural GDP, and so agricultural GDP is used as a proxy for the output capacity of the exporting country. The parameter for this variable is expected to be positive. A larger agricultural sector is expected to have a significant positive influence (synergy effect) on a subsector such as FTC.

Population of the exporting country was included in the model to account for the capacity of the country to consume the good domestically. It is assumed that the larger the population the less the country will export. Thus the significance for this parameter is expected to be negative.

Income effect for the importing country in a GM is generally controlled by including total GDP. Given the countries under analysis have important differences in terms of economy size, living cost and income per capita, a variable with stronger explanatory power for income effect in the importing country is per capita GDP expressed in purchasing power parity (PPP). This analysis is consistent with the findings of Paas (2003) who formally tested the adequacy of the variables concluding that GDP expressed in term of PPP is more suitable. A positive sign for this parameter is expected, meaning that an increase in income in the importing country would lead to an increase of FTC imports. Since FTC is a processed good it is also expected that the parameter for this variable would be one or greater.

Population in the exporting country is included to complement per capita GPD-PPP, since the later controls for the income effect of one individual in the importer country but does not consider the size of that economy. By including population, total purchasing capacity of the importing country is captured.

Once initially processed, FTCs can be stored for long periods of time. Therefore, the volume imported or exported in previous years can have a direct impact on trade in the current year. On the other hand, it is logical to believe that once a trade relationship has been established between two countries it is likely to continue over time. The lag variables, lx_{it-1} and $lm_{it-1,}$ are included in the analysis to account for these occurrences. Signs for these parameters are ambiguous since storage could have a negative influence, while trade relationships could have a positive effect.

Equation 13 will be estimated by maximizing the likelihood function:

$$\log L = \sum_{t=1}^{N} \left[\sum_{t=1}^{T,} \log f\left(y_{ijt}, \beta_0 + \ln \mathbf{x}_{ijt}\boldsymbol{\beta} + \mathbf{f}_{ij}\boldsymbol{\alpha}, \boldsymbol{\theta}\right) \right] \tag{14}$$

$$i = 1, \ldots., N; \; j = 1 \; \ldots. \; N; \; t = 1 \ldots, T$$

Where $f(\ldots)$ is the density function of the Tobit model containing the parameters to be estimated, $\boldsymbol{\theta}$ is a vector of disturbance standard deviation. Equation 14 usually does not have an explicit solution but must be solved iteratively. Inclusion of a set of dummy variables (**f**) may make the maximization viable, but proliferation of dummy variables may create a serious constraint in the procedure due to "nuisance parameters" (Greene, 2004b). In the case of FTC, it would be necessary to create 272 parameters, but since fixed effects are considered to be the same regardless of whether a country exports or imports, the number of parameters added to the model was reduced to 136. This characteristic of GM drastically reduces the "nuisance parameters problem", i.e. the proliferation of dummy variables for each fixed effects to be controlled. Additionally, this characteristic makes the maximization of the function feasible by "brute force", namely by adding a dummy variable for each pair of countries.

The inclusion of fixed effects creates another empirical issue: all time-invariant variables (distance and the dummies the border and free trade agreement) effects will be aggregated and captured by the fixed effects dummy variables. The individual effect of these variables on trade can not be observed from equation 13. Following the procedure of Martinez-Zarzoso and Nowak-Lehmann (2002) a two-step procedure is used to estimate the effect of time-invariant variables. Country-pair effects (α) are regressed on independent time-invariant variables. Hence, based on empirical results from equation 13 the following equation is estimated using OLS with robust standard errors.

$$\alpha_{ij} = \delta_0 + \delta_1 \ln d_{ij} + \delta_2 bo_{ij} + \delta_3 ft_{it} + \varepsilon_{ij} \quad (15)$$

where:

d_{ij} = Distance from country i to country j

bo_{ij} = presence common border between country i and j

ft_{ijt} = existence of free trade agreement between country i and j in the period t.

Distance is a proxy for transport cost and is expected to have a negative effect on trade value. In this case the effect of distance will be reflected on the fixed effects, which have a direct and positive effect on trade value.

The presence of a common border and free trade agreement are two dummy variables commonly included in GM. The presence of either of these two variables is expected to generate an increase in trade, i.e. parameter signs would be positive. Free trade agreements relevant to this study are NAFTA (U.S., Canada, Mexico), EU (Belgium, Denmark, France, Germany, Greece, Italy, Netherlands, UK), Eastern Europe Free Trade Agreements (Hungary, Poland, Turkey) and EU and Mexico. All the agreements were established prior to 1993 with the exception of EU – Mexico that was signed in 2000.

Variables included in equation 13 were selected based on previous studies that used log-likelihood ratio (LR) tests and Akaike's Information Criterion (AIC). The properties of LR tests and AIC for specification of non-linear models used in this study have not been completely specified. Therefore, results of LR test are included as one method to support the selection of variables and not the only criterion.

The LR test is applied to test the null hypothesis that restrictions imposed on the original model do not apply. Five different alternatives to Equation 13 were tested. Alternatives include models where either variables were omitted or alternative proxies were substituted for those variables in Equation 13. The six alternative models that were evaluated are:

1) Including total GDP measured in current U.S. dollars of importing and exporting countries substituting for per capita income at purchasing power parity and population.
2) Including total GDP at purchasing power parity of importing and exporting countries substituting for per capita income at purchasing power parity and population.
3) Excluding the lagged value of total imports and exports.
4) Excluding country-pair fixed effects and including distance and dummy variables for border and FTA (random effects).
5) Excluding time effects.
6) Alternative specification of fixed effects by export or import country.

Models 1 and 2 used alternative proxies to capture income effects while models 3-5 test more parsimonious specifications of the original model and model 6 tests a different set of fixed effects variables.

The interest of the LR test is to compare explanatory power of the variables included in the alternative models with the final set of variables selected for the study. Likelihood ratio tests are used to compare two models where the simpler model (alternative model) is a special case of the more complex model (original model), i.e., "nested". The test statistic is distributed as a chi-squared random variable. The Akaike Information Criterion (AIC) of each model is also included and compared; here the model that presents the smaller estimates is likely to have a stronger explanatory power.

Table 4. Log-likelihood ratio test and AIC estimates for the alternative models

No.	Alternative Model variables [a] Included [b]	Excluded [c]	Degrees of freedom	LR chi^2	AIC
1	gdp_i, gdp_j	gp_i, ag_j, pm_i, px_j	121	62.04***	8406.77
2	gdp_p_i, gdp_p_j	gp_i, ag_j, pm_i, px_j	121	69.19***	8413.91
3		lm_{it-1}, lx_{it-1}	121	383.01***	8727.73
4		$\mathbf{f_{ij}}$	8	959.32***	9078.04
5		$\mathbf{t_{ij}}$	113	21.26 **	8349.99
6	$\mathbf{fx_i, fm_j}$	$\mathbf{f_{ij}}$	49	632.12***	8832.85
	Unrestricted model		123	n/a	8348.72

[a] The number of observation for all the models: 2310

[b] $gdp_i, gdp_j, gdp\_p_i, gdp\_p_j$: GPD in current dollars and GDP in PPP of exporting and importing countries respectively. $\mathbf{fx_i}$, $\mathbf{fm_j}$: fixed effects for exporting and importing countries.

[c] $gp_i, ag_j, pm_i, px_j, lm_{it-1}, lx_{it-1}$: GPD in current dollars, population and one year export/import lagged, respectively.

***, ** denotes a significant test statistic at the 0.01 and 0.05 level respectively. Significant indicates that the alternative model does not have a better fit than the original.

From Table 4 we can see that neither of the two alternatives for capturing the income effects of the exporting country and the output capacity (model 1 and 2) had a better performance than the original model. Model 1 includes total GDP in current dollars for both trade countries as alternative proxy variables. Total GDP in the importing country is substituted for per capita GDP-PPP and population, and total GPD in the exporting country is substituted for agricultural-GDP and population. The results of the LR-test and AIC indicate that the original model has a stronger explanatory power; therefore, the hypothesis that the alternative model has a stronger explanatory power is rejected. The second alternative model presents total GPD-PPP for both trader countries as a proxy for agricultural GDP and population in the case of exporting country and GDP-PPP per capita and population in the case of importing country. According to the LR-test the unrestricted model has a better performance and it is preferred to the alternative. The AIC also presents a smaller number for the original model in both cases.

Models 3, 4 and 5 exclude some variables from the original model. The LR test indicates whether coefficients of the excluded variables are equal to zero or not. Results do not show coefficient value of the excluded variables equal to zero for any of the cases, therefore, the null hypothesis that restrictions do not apply is rejected. The total value of exports/imports from a previous year contributes significantly to explain the trade flow of FTC. To omit fixed effects from the model would reduce the explanatory power of the model, as well as leave out business cycle dummy variables.

Model 6 presents an alternative set of fixed effects variables. Here it is assumed that fixed effects are more related to individual characteristics of the exporter and importer rather than to the specific trade characteristics between two countries. These individual characteristics could be factors such as trade facilities (roads, harbors, airports, etc.) or trade services (telecommunication, market information services, etc.). According to the

LR test it was possible to establish that the original model is preferred to the alternatives. The AIC also indicates the unrestricted model has a better performance.

CHAPTER IV

4. Results

This chapter is divided into two parts. The first part presents the result of the GM estimation, including its marginal effects analysis. The second part assesses the FTC export potential of the countries included in this study.

4.1 Model Estimation Results

Estimation results for equation 13 are reported in Table 5. The model was run with 2,309 observations, 31 country pairs were excluded from the estimation since they did not report trade during any year of analysis, and consequently it was not possible to estimate a fixed effects parameter for these pairs. For example, Japan and Poland did not report FTC trade during any year included in the analysis. The degree of censoring of the data set after dropping those observations was 53 percent. The coefficients presented in Table 5 cannot be read directly as elasticities; however, the sign and significance of the coefficients indicate the direction of impacts. The overall significance of the model is high, since the probability of non-significance of the Chi-square statistic of the model is very low. The explanatory power of the model is moderate but relevant. The pseudo R^2 0.192 is near a range that is considered relevant for non-linear models (0.205 - 0.259).

Table 5. Tobit estimates with fixed effects for trade value

Variable	Coeff.	Model Information	
gp_j	6.74 ***	Number of obs	2,309
pm_j	3.31 *	LR chi2(111)	1,926
ag_i	1.97 ***	Prob > chi2	.000
px_i	1.67	Pseudo R2	0.192
lx_{it-1}	0.87 ***	Log likelihood	-4,066.84
lm_{it-1}	1.67 ***	Left-censored observations	1,231

Country – pair fixed effects

Pair	Coeff.	Pair	Coeff.	Pair	Coeff.
AUT BEL	12.82 *	CAN FRA	1.68	GRE NED	13.97 *
AUT CAN	16.73 ***	CAN GER	2.19	GRE POL	15.02 **
AUT DEN	13.55 *	CAN HUN	10.90	GRE TUR	19.39 ***
AUT FRA	5.37	CAN ITA	-2.01	GRE UK	17.81 ***
AUT GER	0.34	CAN JAP	7.74	HUN ITA	6.96
AUT HUN	11.84	CAN NED	10.19	HUN JAP	1.95
AUT JAP	17.59 ***	CAN POL	11.08 *	HUN MEX	15.86 **
AUT MEX	21.07 ***	CAN TUR	4.39	HUN NED	20.39 ***
AUT NED	12.43 *	CAN UK	7.57	HUN POL	26.14 ***
AUT POL	10.11	CAN US	12.57 *	HUN TUR	17.35 ***
AUT TUR	4.45	DEN FRA	13.40 *	HUN US	-1.88
AUT UK	6.32	DEN GER	19.49 ***	ITA JAP	-1.83
AUT US	9.14	DEN GRE	10.11	ITA NED	16.17 ***
AUS BEL	22.36 ***	DEN NED	21.16 ***	ITA POL	14.05 **
AUS DEN	13.57	DEN POL	18.96 ***	ITA TUR	11.40 *
AUS FRA	7.42	DEN TUR	11.92 *	ITA UK	1.65
AUS GER	20.69 ***	DEN UK	18.53 ***	ITA US	-2.58
AUS GRE	12.46	DEN US	0.13	JAP NED	-0.57
AUS HUN	24.29 ***	FRA GER	12.84 *	JAP US	6.09
AUS ITA	17.04 ***	FRA GRE	9.48	MEX US	3.60
AUS NED	20.84 ***	FRA HUN	12.19 *	NED POL	17.18 ***
AUS POL	20.18 ***	FRA ITA	14.81 **	NED TUR	15.95 **
AUS TUR	-8.64 ***	FRA JAP	9.04	NED UK	17.40 ***
AUS UK	5.09	FRA NED	16.38 ***	NED US	4.96
AUS US	4.72	FRA POL	13.68 **	POL UK	14.88 **
BEL CAN	9.69	FRA TUR	10.62	POL US	-5.66
BEL DEN	26.47 ***	FRA UK	15.01 **	TUR UK	14.20 **
BEL FRA	20.41 ***	FRA US	2.37	TUR US	-2.89
BEL GER	18.87 ***	GER GRE	19.06 ***	UK US	-0.64
BEL GRE	24.07 ***	GER HUN	19.03 ***		
BEL HUN	24.10 ***	GER ITA	13.89 **	Business cycle effect	
BEL ITA	13.90 **	GER NED	16.85 ***	1994	-1.12
BEL MEX	5.78	GER POL	17.15 ***	1995	-0.27
BEL NED	23.53 ***	GER TUR	13.17 *	1996	-0.50
BEL POL	19.54 ***	GER UK	12.00 *	1997	-0.02
BEL TUR	16.72 ***	GER US	-0.38	1998	-1.17
BEL UK	20.23 ***	GRE HUN	6.24	1999	-0.85
BEL US	8.94	GRE ITA	14.17 **	2000	-1.06
				2001	-2.24 ***
Cosnt	-147.85 ***			2002	-0.54
_se	6.28			2003	-2.33 ***

Significant: *** at 1% , ** at 5%, * at 10%

Per capita GPD-PPP in the importing country has a positive effect on FTC trade (at one percent significance). As per capita incomes rise, trade increases. Likewise, as population increases, trade increases, although this coefficient is significant at just the 10 percent level. Both GDP-PPP and population are measures of demand in the importing country and their effects are as expected. The size of agricultural output in the exporting country shows a positive and significant (at 1 percent) effect on FTC trade. Population in the exporting country could not be established as a source of significant variation in the FTC flow, therefore the absorption capacity (domestic demand) for FTC of the exporter shows the export-oriented nature of the good analyzed. The lagged value of trade was significant for both exporting and importing countries with a positive effect on subsequent valued traded. So, the positive impact of the trade relationship built over time outweighs any negative impacts on FTC trade such as storage ability.

Looking at the results for country-pair[13] fixed effects some points can be highlighted. In general the fixed effects (distance, border, FTA and any other characteristics that are not likely to change over time, such as historical links) of the Western European countries present a positive and significant influence over trade. Therefore, Western European countries in general have been able create strong trade relationships among themselves based on their geographic location and trade agreements. For example, more than 60 percent of France's FTC demand is covered by Western European countries. Net exporting countries such as Hungary, Turkey and especially Poland have also developed solid trade linkages with their main trade partners, despite the lack of formal trade

[13] None of the countries can be identified as exporters or importers. The analysis is centered on the trade relationship.

agreements. Poland's exports to Germany, Belgium and Netherlands have had a consistent and incremental upward trend from 1993 to 2003. On the other hand the U.S., which plays an important role in the FTC world market, has a positive and significant trade link only with Canada (10 percent), its historical trade partner. This suggests that the U.S. has built its FTC trade relationships on time variant characteristics (such as weather) rather than on fixed factors (such as FTA, been Canada the exception).

In order to be able to discuss effects of distance, border and FTA on aggregated FTC trade, a second step estimation was undertaken (See details in Chapter III). Results are presented in Table 6. Even though this second step procedure has its limitations, particularly when assessing the effects of the dependent variable directly on trade, it provides a better understanding of the individual effects of time-invariant variables on trade flow analysis. All variables included in this model were found to be significant at the one percent level. Again, a direct interpretation of the coefficients is not possible but the effect of each variable on the individual fixed effects and consequently on FTC trade is as expected. Distance, as was mentioned previously, is a proxy for transportation costs. The negative sign of this coefficient implies that the greater the distance between two countries the lower the level of trade between them. The positive and significant signs of the coefficients of border and FTA seem to indicate that their presence positively affects the country-pair fixed effects and in turn FTC trade among the pair of countries. Based on relative magnitude of the estimated coefficients the effect of a FTA between two countries will have nearly the same effect as if those countries shared a common border. A common border does not just proxy geographic location, but also could imply cultural similitude, historical linkages, migration flows, etc. These factors, as a set, may have a positive influence on trade.

Table 6. OLS estimation individual effects

Dependent variable: Individual effects from Eq. 16	
Independent variables	Coeff.
Distance	-1.281***
Border	3.938***
FTA	3.584***
Constant	20.592***
N	105
R-squared	0.22
Root MSE	6.06

*** Significant at 1%

4.2 Marginal Effects

The marginal effect of any of the variables on trade value depends on the probability that trade value is greater than zero (see table 5). Tobit estimates are multiplied by a factor (for details see Wooldridge, 2002 p. 522) and thus obtaining the marginal effect of the explanatory variables on the conditional expectation. There are two conditional expectations of interest:

1) Expected trade value given trade existence, (i.e. trade value > 0) and the explanatory variables

$$E(\text{Trade value} \mid \text{Trade value} > 0, \mathbf{x}), \text{ and}$$

2) Expected trade value given only the set of explanatory variables

$$E(\text{Trade value} \mid \mathbf{x}).$$

The first estimate provides information on the expected trade value for given values of $\mathbf{x}$ in the subset of observations where trade was observed. Expected trade value, given trade occurs, is more adequate for a profit assessment, since it considers the real demand. The second expected value calculated is not conditional to existence of trade and uses the whole set of observations to predict value of trade. The latter case is relevant for demand analysis, where the possibility exists that the dependent variable becomes greater than zero (i.e.: a change demand equal zero to some positive value) without a change in independent variables. The factor used to estimate the marginal effects is a value strictly between zero and one and is based on these two expectations (Wooldridge, 2000, p. 567).

Table 7 presents results of the marginal effect conditional on value of trade greater than zero and Table 8 results of the marginal effects conditional only on the values of the explanatory variables, i.e. this estimation include the expected value of trade for those country-pair observations of a particular year where the value of trade observed was zero. A key difference between these two calculations is that the second accounts for the fact that a country pair that has not traded in the past may chose to trade if the conditions change. Significance levels as well as the direction of the effects in both cases are very similar to the original model estimation. The discussion below will focus on values reported in Table 8.

According to results, FTC trade value is income elastic: a one percent increase in income could represent an expected 3.61 percent increase in the value of FTC traded (using the estimates not conditional on trade value greater than zero), holding the rest of the variables constant. That is consistent with the literature that finds processed goods generally have income elasticities greater than one. (Ash, 2004; Babula and Corey, 2005).

Thus the natural target markets for exporters that are expanding their production should be countries where the income growth is constant and solid. It is important to notice that any income decrease from the trade partner would have serious negative consequences in the volume of exports. The fact that the income elasticity is greater for the "unconditional"[14] analysis could be because the market is considered larger for the same amount of product.

An increase in population of the importing country suggests the generation of increased imports of FTC. A one percent increase in population in a given country would mean an expected increase of 1.78 percent increase FTC demand, ceteris paribus.[15] However, it is important to consider that some of the countries included in the study, particularly European countries, have less than a 1 percent rate of growth. In addition, the income effect is likely to be the predominant demand shifter.

Size of the agricultural sector in the exporting country has a positive effect on exports. This effect is slightly larger when analysis includes those country-pairs that did not trade. Thus Mexico, a country that exports FTC to a few countries, might conceivably engage in trade with other countries if its agricultural sector grew and generated the proper conditions. The growth of exports will be almost proportional to the rate of growth of the

[14] The expected value is still conditional on the values of the explanatory variables.

[15] Mathematically population is actually considered twice as an independent variable twice in the model, since per capita GPD-PPP also incorporates population. Performing some mathematical operations with logarithms it is not difficult to show that population could have a negative coefficient (from table 7: -1.31). However, since all the variables, including GDP-PPP are held constant, an increase in population would also imply a reduction in per capita income, and given the income elasticity of FTC, this would lead to a decrease in demand.

agricultural sector, i.e. an increase of one percent in the agricultural GDP would potentially generate a 1.05 percent increase in FTC trade.

The effect of the total value of FTC exported one lagged year has a larger effect on the value of FTC traded in the current year than the total amount imported in the past year. FTC markets are export driven markets and the capabilities that a country may develop in order to promote exports has a stronger impact on FTC flows than the development of domestic markets in importing countries. Nonetheless, the combination of both will have a most favorable impact. The loss of market share due to a bad tart cherry production year, such as what happened with U.S. in 2002, could also have a negative impact on the next year's exports. In fact, it is expected that for every percent of market loss in a given country, the following year the demand will decrease by almost half percent.

The magnitudes of country-pair fixed effects (again reported in Tables 7 and 8) reveal that the European countries have strengthened their trade relationships based on the time-invariant factors. Most of the European countries will trade amongst themselves between 15 and 24 percent more than the expected value of trade among those countries that have not engaged in trade of FTC.[16] Poland, Hungary and Turkey have consolidated their trade links in Europe rather than with countries in other regions. It is expected that the trade of these three countries with Western Europe would be between 10 and 17 percent greater than the expected value of the countries that have not engaged in trade.

[16] The "unconditional" expectation assigns a expected value of trade for those countries that have not shown trade. The expected value is based on their values of $\mathbf{x}_{ij}$

Table 7. Marginal effects of Tobit estimates conditional on trade value greater that zero

Variable	dy/dx	
gp_j	2.58	***
pm_j	1.27	*
ag_i	0.75	***
px_i	0.64	
lx_{it-1}	0.33	***
lm_{it-1}	0.64	***

Country – pair fixed effects

Pair		dy/dx		Pair		dy/dx		Pair		Coeff.	
AUT	BEL	8.39	*	CAN	FRA	0.70		GRE	NED	9.45	*
AUT	CAN	12.08	***	CAN	GER	0.93		GRE	POL	10.44	**
AUT	DEN	9.06	*	CAN	HUN	6.71		GRE	TUR	14.69	***
AUT	FRA	2.64		CAN	ITA	-0.70		GRE	UK	13.13	***
AUT	GER	0.13		CAN	JAP	4.23		HUN	ITA	3.68	
AUT	HUN	7.52		CAN	NED	6.12		HUN	JAP	0.82	
AUT	JAP	12.92	***	CAN	POL	6.87	*	HUN	MEX	11.24	**
AUT	MEX	16.35	***	CAN	TUR	2.07		HUN	NED	15.67	***
AUT	NED	8.04	*	CAN	UK	4.10		HUN	POL	21.37	***
AUT	POL	6.06		CAN	US	8.17	*	HUN	TUR	12.68	***
AUT	TUR	2.10		DEN	FRA	8.92	*	HUN	US	-0.66	
AUT	UK	3.25		DEN	GER	14.79	***	ITA	JAP	-0.64	
AUT	US	5.27		DEN	GRE	6.06		ITA	NED	11.54	***
AUS	BEL	17.62	***	DEN	NED	16.44	***	ITA	POL	9.53	**
AUS	DEN	9.08		DEN	POL	14.26	***	ITA	TUR	7.14	*
AUS	FRA	4.00		DEN	TUR	7.59	*	ITA	UK	0.68	
AUS	GER	15.97	***	DEN	UK	13.84	***	ITA	US	-0.88	
AUS	GRE	8.07		DEN	US	0.05		JAP	NED	-0.21	
AUS	HUN	19.54	***	FRA	GER	8.41	*	JAP	US	3.10	
AUS	ITA	12.38	***	FRA	GRE	5.54		MEX	US	1.64	
AUS	NED	16.11	***	FRA	HUN	7.83	*	NED	POL	12.52	***
AUS	POL	15.46	***	FRA	ITA	10.24	**	NED	TUR	11.32	**
AUS	TUR	-2.26	***	FRA	JAP	5.20		NED	UK	12.73	***
AUS	UK	2.48		FRA	NED	11.74	***	NED	US	2.40	
AUS	US	2.26		FRA	POL	9.18	**	POL	UK	10.31	**
BEL	CAN	5.71		FRA	TUR	6.48		POL	US	-1.68	
BEL	DEN	21.71	***	FRA	UK	10.42	**	TUR	UK	9.67	**
BEL	FRA	15.69	***	FRA	US	1.02		TUR	US	-0.97	
BEL	GER	14.17	***	GER	GRE	14.31	***	UK	US	-0.24	
BEL	GRE	19.32	***	GER	HUN	14.31	***	Business cycle effect			
BEL	HUN	19.35	***	GER	ITA	9.38	**				
BEL	ITA	9.39	**	GER	NED	12.19	***	1994		-0.41	
BEL	MEX	2.90		GER	POL	12.48	***	1995		-0.10	
BEL	NED	18.79	***	GER	TUR	8.71	*	1996		-0.19	
BEL	POL	14.83	***	GER	UK	7.67	*	1997		-0.01	
BEL	TUR	12.07	***	GER	US	-0.14		1998		-0.43	
BEL	UK	15.51	***	GRE	HUN	3.19		1999		-0.32	
BEL	US	5.12		GRE	ITA	9.64	**	2000		-0.39	
								2001		-0.79	***
								2002		-0.20	
								2003		-0.82	***

dy/dx is for discrete change of dummy variable from 0 to 1
Significance: *** at 1% , ** at 5%, * at 10%

Table 8 Marginal effects of Tobit estimates not conditional on trade value greater that zero

Variable	dy/dx.
gp_j	3.61 ***
pm_j	1.78 *
ag_i	1.05 ***
px_i	0.90
lx_{it-1}	0.47 ***
lm_{it-1}	0.89 ***

Country – pair fixed effects

Pair		dy/dx	Pair		dy/dx	Pair		dy/dx.
AUT	BEL	10.59 *	CAN	FRA	0.99	GRE	NED	11.72 *
AUT	CAN	14.45 ***	CAN	GER	1.32	GRE	POL	12.76 **
AUT	DEN	11.30 *	CAN	HUN	8.72	GRE	TUR	17.10 ***
AUT	FRA	3.71	CAN	ITA	-0.95	GRE	UK	15.52 ***
AUT	GER	0.19	CAN	JAP	5.77	HUN	ITA	5.07
AUT	HUN	9.63	CAN	NED	8.05	HUN	JAP	1.16
AUT	JAP	15.31 ***	CAN	POL	8.90 *	HUN	MEX	13.59 **
AUT	MEX	18.77 ***	CAN	TUR	2.92	HUN	NED	18.09 ***
AUT	NED	10.21 *	CAN	UK	5.61	HUN	POL	23.81 ***
AUT	POL	7.97	CAN	US	10.35 *	HUN	TUR	15.06 ***
AUT	TUR	2.97	DEN	FRA	11.16 *	HUN	US	-0.89
AUT	UK	4.51	DEN	GER	17.20 ***	ITA	JAP	-0.87
AUT	US	7.05	DEN	GRE	7.97	ITA	NED	13.89 ***
AUS	BEL	20.05 ***	DEN	NED	18.86 ***	ITA	POL	11.80 **
AUS	DEN	11.33	DEN	POL	16.66 ***	ITA	TUR	9.21 *
AUS	FRA	5.48	DEN	TUR	9.71 *	ITA	UK	0.97
AUS	GER	18.39 ***	DEN	UK	16.24 ***	ITA	US	-1.17
AUS	GRE	10.24	DEN	US	0.07	JAP	NED	-0.30
AUS	HUN	21.97 ***	FRA	GER	10.61 *	JAP	US	4.31
AUS	ITA	14.76 ***	FRA	GRE	7.37	MEX	US	2.32
AUS	NED	18.53 ***	FRA	HUN	9.98 *	NED	POL	14.90 ***
AUS	POL	17.88 ***	FRA	ITA	12.55 **	NED	TUR	13.68 **
AUS	TUR	-2.52 ***	FRA	JAP	6.96	NED	UK	15.12 ***
AUS	UK	3.48	FRA	NED	14.11 ***	NED	US	3.37
AUS	US	3.18	FRA	POL	11.43 **	POL	UK	12.62 **
BEL	CAN	7.57	FRA	TUR	8.46	POL	US	-2.07
BEL	DEN	24.14 ***	FRA	UK	12.74 **	TUR	UK	11.95 **
BEL	FRA	18.11 ***	FRA	US	1.44	TUR	US	-1.29
BEL	GER	16.57 ***	GER	GRE	16.73 ***	UK	US	-0.33
BEL	GRE	21.75 ***	GER	HUN	16.72 ***			
BEL	HUN	21.79 ***	GER	ITA	11.64 **	Business cycle effect		
BEL	ITA	11.65 **	GER	NED	14.57 ***	1994		-0.57
BEL	MEX	4.05	GER	POL	14.87 ***	1995		-0.14
BEL	NED	21.22 ***	GER	TUR	10.93 *	1996		-0.26
BEL	POL	17.25 ***	GER	UK	9.79 *	1997		-0.01
BEL	TUR	14.44 ***	GER	US	-0.20	1998		-0.59
BEL	UK	17.93 ***	GRE	HUN	4.44	1999		-0.44
BEL	US	6.87	GRE	ITA	11.92 **	2000		-0.54
						2001		-1.07 ***
						2002		-0.28
						2003		-1.11 ***

For Dummy variables dy/dx is for discrete change of dummy variable from 0 to 1
Significance: *** at 1%, ** at 5%, * at 10%

An interesting case is Australia (AUT) which, despite the fact that its share in FTC trade is limited, has developed trade flows facilitated by the fixed conditions of trade. This analysis does not show the direction of trade flow, but we can say that Australian FTC trade with Mexico and Canada, and Japan has been strengthened by fixed effects.

The U.S. shows a positive and significant (10 percent) fixed effect with Canada. The FTC trade between these two countries is expected to be almost nine percent higher than the expected value of the control countries. The U.S. and their FTC partners (besides Canada), whether as importers or exporters have not been able to make a difference in the value of trade based of factors such as geographic position, cultural similarity or special trade agreements.

A surprising, result is the marginal effect for fixed effects between Austria and Turkey. The trade value among these two countries is expected to be 2.52 percent less that the assigned expected value for those countries that do not trade FTC. This is the only country-pair that showed a significant negative impact from fixed effects.

Additional empirical results show the business cycle effects are significant for two years, 2001 and 2003 (using 1993 as the base year). Negative signs on these coefficients seem to contradict general trends in the FTC market, since the total value of FTC traded worldwide has increased substantially between 1993 and 2003. The negative and significant results for 2001 and 2003 deserve special consideration. In 2001 the business cycle marginal effect is -1.07 (significant at 1 percent), indicating that the expected value of trade between any two given countries will be 1.07 percent less than it was in 1993 (Table 8). Since it is known that the total value of FTC trade in 2001 is larger than in 1993, the logical conclusion is that individual countries have diversified their markets and are likely to see, on average, lower volumes of trade between any given pair of countries.

Expected Values

The estimation of the expected value of exports requires the addition of one unit to the dependent variable in order to calculate the logarithm when $y_{ijt} = 0$. To calculate E(y|x), from log(1 + y), w was set equal to log(1 + y), and then y = [exp(w) – 1], thus

$$y = \{\exp[\max(0, \mathbf{x\beta} + \varepsilon)] - 1\} \tag{16}$$

To estimate $E(y_{ijt})$ equation 13 was estimated 1500 times for each pair of countries, substituting the MLE estimates from equation 13 for $\boldsymbol{\beta}$ and ε was drawn (1500 times) from a normal distribution with mean equal to zero and variance equal to the standard deviation of the model squared, $\varepsilon \sim \text{Normal}(0, s^2)$. Finally y_{ijt} is the result of averaging the above equation across all the draws (Wooldridge, 2005).

Trade Shares and fixed effects

Figure 3 shows a graphical analysis of fixed effects average values, trade share and number of significant fixed effects within the region. As you move from right to left the trade between those specific regions accounts for a greater share of world volume. As you move from bottom to top, the fixed effects factors have a greater (i.e. positive) impact on trade between the specified regions. The values next to the circles represent the number of significant fixed effects that countries within the regions have, for example, between West European and Eastern European countries there are 21 significant fixed effect.

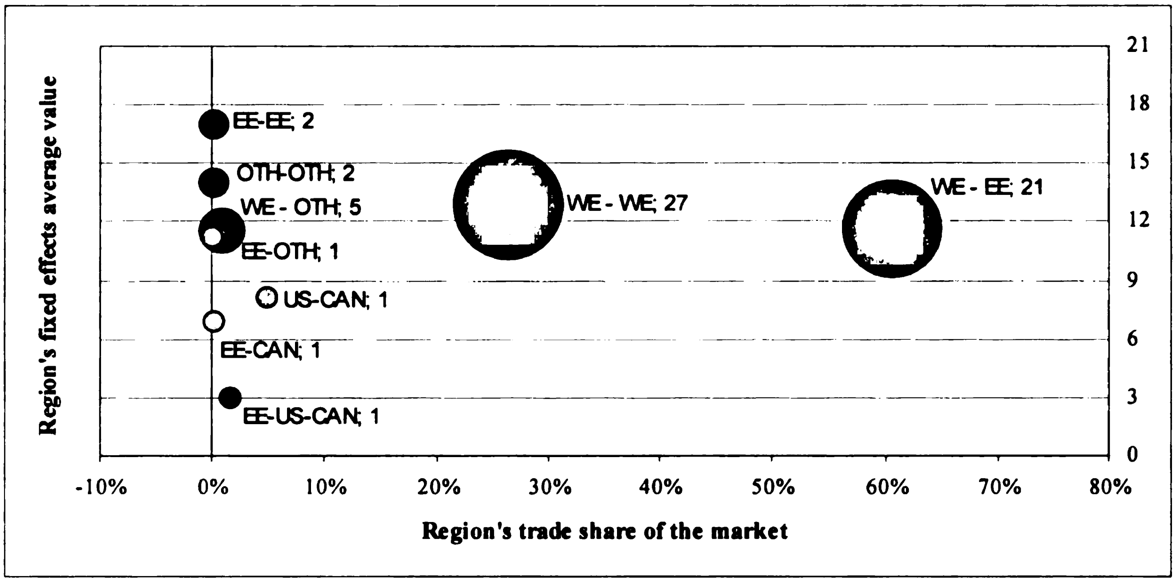

Figure 3. Selected regions: Graphical analysis of fixed effects average values, trade share and number of significant fixed effects within the region.
Source: Study results
EE, Eastern Europe; WE, Western Europe; OTH, Others (Australia, Mexico, Japan)

FTC trade between Western and Eastern European countries accounts for more than 60 percent of total FTC trade in the model. Fixed effects have a significant impact on FTC trade in 21 (out of 27) country-pairs within these two regions and ,on average, the countries represented are expected to export 13 percent more than the expected value assigned by the marginal effect analysis. Likewise, the trade among Western European countries reveals that these countries account for 26 percent of the market, nine countries from this region show 27 significant fixed effects, and on average, trade among these countries is expected to be 11 percent higher than the expected value assigned by the analysis to those countries that do not trade. These two inter-regional analyses clearly prove the importance of building trade relationships based on time-invariant factors in order to consolidate market participation.

The trade among Eastern European countries shows a high expected value of trade (17), however, this potential is not translated into market share. The three countries of this region are net exporters to other regions having insignificant trade flows amongst themselves.

The FTC trade among Canada and the U.S. represents 5 percent of the market. This important market share is backed up by the single significant fixed effect that U.S. showed with Canada. The fixed effects value is relatively low (8), and in this case, the importance of the time invariant variable to strengthen a market relationship is also evident.

Analyzing the trade among Eastern European countries, and the US and Canada as a block, it is possible to identify just one significant fixed effect (Canada and Poland). The trade between these two regions represents slightly more than two percent of the FTC trade from which a large part is given by the trade between U.S. and Poland. This could mean that the Eastern European countries could have a more relevant role in the US – Canada trade block. More specifically, Poland could gain some space in Canada's market pushing the U.S. aside from the existing market.

The FTC trade among "others", being Japan, Australia and Mexico, has a relatively high fixed effects value, as well as the Western European countries and "others". However, the share of the market of this intra- and inter-regional trade is insignificant. This can be explained from two different perspectives. The first being the intra trade among "other" countries is incipient since none of these countries are important FTC producers, therefore, they can not take advantage of the presence of – probably – natural time invariant factors that could promote FTC trade. On the other hand, Western European countries and "others" have not consolidated a significant share of the market probably because Western European countries have not targeted these markets.

4.3 Frozen Tart Cherry Export Potential

The export potential of FTC was estimated by subtracting the expected value of exports conditional on the independent variables ($\mathbf{x}_{ijt}$) from the average of exports from 1993 to 2003 for each pair of countries. Positive values indicate an export potential while negative values (not reported) indicate that the exporting country has exported on average more than the model results would predict.

Table 9. Export potential for selected countries expressed as percent of the annual export average.

	Export potential (%)											
	AUT	AUS	BEL	CAN	DEN	FRA	GER	GRE	NED	POL	TUR	U.S.
AUT	-	-	-	-	-	-	-	-	-	-	-	-
AUS	-	-	-	-	-	-	72	-	-	-	-	-
BEL	-	-	-	-	-	58	28	-	82	-	-	-
CAN	-	-	-	-	-	-	-	-	-	-	-	363
DEN	41	-	-	-	-	270	-	-	-	-	-	-
FRA	-	-	-	-	-	-	-	-	-	-	-	-
GER	-	51	-	-	28	34	-	155	146	1195	377	-
GRE	-	-	-	-	-	-	-	-	-	-	-	-
HUN	-	-	-	-	-	-	-	-	-	123	-	-
ITA	-	-	-	-	-	-	-	-	-	1	-	-
JAP	-	-	-	-	-	-	-	-	-	-	-	9
MEX	-	-	-	-	-	-	-	-	-	-	-	-
NED	-	-	-	-	-	-	-	-	-	-	25	-
POL	-	-	-	-	-	-	-	-	-	-	-	-
TUR	-	-	-	-	-	-	-	-	-	-	-	-
UK	-	-	13	-	-	29	-	-	-	7	-	-
U.S.	-	-	-	100	-	-	-	-	-	-	-	-

Countries excluded from the chart did not preset any potential or it was minimal. For the complete chart see Annex 3.

Table 9 shows the export potential of FTC for selected countries. The numbers in the chart represent the percentage that an exporting country could potentially increase its exports over historical annual average exports given factors in the gravity model.[17] For example, results for Poland indicate a large potential to export to Germany. If German demand increases, Poland would likely be the best candidate to provide this supply. This result is not surprising since Poland and Germany are currently the largest exporter and importer respectively of FTC and the pair of counties have the characteristics that a GM

[17] That is to say that these countries are "under-traded" with its respective trade partner. That could be due to factors that have not been included in the model or because the trade among these trade partners has not been sufficiently aggressive.

would predict as a high flow of trade. That is a large economy vs. a relative small and a close geographic position. Other good candidates to cover increases in German demand are Turkey, Greece and Netherlands.

The U.S. has the potential to triple the value of FTC exports to Canada. No other country shows a potential to cover any extra demand from Canada. On the other hand, Canada may also increase its exports to U.S.; this result is backed up by the presence of time-invariant factors that create a favorable trade scenario. Japan represents a market that U.S. exporters could explore further and where the U.S. has the advantage that it is the only potential supplier for such a market.

France has four potential markets (Belgium, Denmark, Germany and United Kingdom) to where it could increase its exports of FTC. It is probable that these potential markets are based in part by France's geographic position and trade agreements. The fixed effects for these countries showed a positive and significant effect on the trade flow.

CHAPTER V

5. Conclusions

This chapter presents the conclusions of the study at three levels. In the first section the analysis examines the conclusions of the empirical analysis of FTC using a Tobit model with fixed effects. The second part focuses on the specification of the GM for a specific commodity. Finally, the third part presents some general conclusions and recommendations that are relevant for policy makers, and future research.

5.1 Frozen Tart Cherry Trade Analysis

Frozen tart cherry (FTC) international trade is concentrated in a reduced number of countries. The 17 largest exporters and/or importers handle 87 percent of world traded volume of FTC. Poland's exports supply 55 percent of the world FTC demand and Germany imports 50 percent of the world supply. Netherlands and Belgium are also important players in the FTC market, both countries are important suppliers as well as buyers. The U.S. is a net exporter of FTC, although in recent years, its share in world imports has increased as well.

The results of the GM using a Tobit model for FTC are consistent with most of the GM literature. The income effect and the output effect showed a positive and significant influence on trade. The total import and export lagged value of FTC had also a positive effect on trade value, which indicates that trade relationships built over time between two countries are relevant to explain the value of FTC traded.

According to the results of country-pair fixed effects, the strong trade relationships among Western European countries also apply for FTC. Western European suppliers and buyers have taken advantage of their geographic position and trade agreements to positively influence FTC trade among themselves. In fact, the FTC trade among the nine Western European countries included in the study represents over 28 percent of the total FTC market. This block showed 27 significant fixed effects.

Hungary, Turkey and especially Poland, have also created strong FTC trade relationships based on time-invariant variables with their counterparts in Western Europe. This trade relationship has been established in spite of the lack of trade agreements. Between the countries of these two regions 21 significant fixed were found (out of 27 possible), and as a result of this strong connection the trade between these two regions represents 61 percent of the FTC trade. This case as well as the one presented above, demonstrates the importance of time invariant factors in order to consolidate FTC markets.

By contrast, the U.S. has not created FTC trade relationships based on time-invariant factors with any other country besides Canada. This sole trade relationship, where time-invariant variables are significant, represents 5 percent of the total FTC market. The rest of U.S. FTC trade relationships (more than 50 percent of its exports) are likely to be based on market opportunities that change over time.

The two-step procedure was useful to clarify the role that the variables distance, presence of common border, and FTA have on fixed effects. As was expected, distance has a negative and significant impact on fixed effects and consequently on FTC trade. Moreover, FTA and presence of border have relatively the same positive effect on trade of FTC. Here it is important to highlight the positive and significant relationship of FTA with FTC trade, despite the fact that FTAs have a broad scope and that a commodity such as FTC is unlikely to be treated specifically in these agreements.

From the marginal analysis of the model, it can be observed that the FTC trade value is income elastic (3.61). A one percent increase in income in an importer country would increase imports by 3.61 percent. This result was expected for a processed good such as FTC. The average rate of growth of the per capita GDP-PPP during the last five years has been positive for all FTC importing countries, representing an important opportunity to expand markets for the exporting countries. Australia, Canada, and United Kingdom appear to be more attractive markets in this respect.

The output elasticity (i.e. agricultural GDP) for the exporting country is almost unitary, which seems to imply that this particular sector is well integrated in the agricultural sector, and any shift in the aggregate sector would impact the export capability of FTC in the same proportion. Countries like Belgium, Netherlands, Poland and Turkey (all of them net exporters) should take this factor into account, since in the last five years they had an agricultural sector with a negative average rate of growth which in turn impacts export capabilities.

The positive and significant values for the marginal effects of the lagged total FTC exported value, as well as the lagged total FTC imported value, illustrate the relevance of building trade relationships over time. Even though FTC can be stored for more than a year, importing countries do not take advantage of this feature so as to not affect next year's imports. In 2002 Poland gained an important share of the U.S. internal FTC market, this fact could be critical for the U.S. FTC industry if Poland decided to be more aggressive with this market and started building long-term trade relationships with the U.S. buyers.

The analysis of country-pair fixed effects confirms that the Western European countries have strong trade relationships based on the time-invariant factors. It is expected that FTC trade amongst Western European countries would be between 15 and 24 percent more than the expected value assigned by the model to those countries that have not engaged in trade of FTC. This block of countries accounts for 26 percent of the FTC market.

In the same analysis, when Eastern European countries (Poland, Hungary and Turkey) trade with Western European countries, the expected value of trade is between 10 and 17 percent greater than the expected value of the control countries. The Eastern European countries have consolidated their trade links with Western Europe in spite of the lack of a FTA. Out of 27 trade relationships between Western and Eastern European countries, 21 resulted in having significant fixed effects. The trade between these two regions represents 62 percent of the FTC market. It is clear that the Western European countries have taken advantage of their geographic location, borders and other time invariant factors (e.g. cultural similitude). Although none of these countries have created FTC trade links based on fixed factors with countries in other regions besides Poland with Canada.

The U.S. is an important player in FTC markets despite the fact that it has not established trade relationships based on FTA or geographic position (other than Canada). The trade between the U.S. and Canada accounts for 5 percent of the total FTC market. This important share could be threatened by the fact that Poland and Canada do have significant fixed effects in their FTC trade relationship.

Evaluating the expected value from the model, it was possible to make an analysis of export potential. Results indicate that Germany is the most important potential market. Any German demand expansion could be more likely covered by Poland, although Turkey and Netherlands are also potential candidates to cover that demand. The U.S. could have two market opportunities to expand exports: Canada and Japan. In both cases the U.S. is the only potential supplier. On the other hand, according to the results, if the U.S. expands its FTC demand, Canada is the most likely country to fulfill that extra demand. There is a clear correlation between potential markets and fixed effects significance; this could mean that most of the potential markets that the analysis showed are based on factors such as distance, FTA or the presence of common border.

5.2 The Model

The analysis of international trade in specific agri-food commodities using a GM needs to consider three issues: 1) the use of panel data 2) censored dependent variable (corner solutions) and 3) fixed effects. Statistical characteristics of the data make a Tobit model with fixed effects using panel data, estimated by MLE, the recommended estimation procedure. This estimation procedure, analyzed by Greene (2004b), requires that the data fulfills some minimum requirements. These requirements can be summarized as follows: the period of time should be greater than five years; at least ten countries should be included in the analysis; the degree of censoring, namely the portion of zeros in the dependent variable (value of trade) should be greater than 40 percent; and lastly, the independent variables included in the model have to follow a Normal, Chi-squared or AR(1) distribution. If these requirements are met, it is expected that results of the estimation will be robust.

The way that fixed effects (pair wise) are set in a GM helps reduce the over-parameterization problem of Tobit models with fixed effects. Most of the time-invariant variables (fixed effects) will have the same impact on trade between two countries regardless of the trade position of the countries (as exporter or importer). This particular feature of the GM reduces the fixed effects parameters to be estimated by half, and the model estimation is feasible by "brute force", .i.e. by adding a dummy variable for each pair of countries and maximizing the likelihood function directly.

Aggregated trade analysis using GM generally controls for income and output effects by including total GPD of the importing and exporting countries respectively. When it comes to a specific good, particularly an agri-food commodity, those variables may not be the most appropriate to control for income and output effects. According to the LR-test, Agricultural GDP is preferred over total GPD for the case of the exporting countries and per capita GDP expressed in purchasing parity power is preferred over total GDP for the importer countries.

The use of fixed effects to estimate a GM implies that all time invariant variables are excluded from the model. The effects of variables such as distance and border are captured by the fixed effects dummy variables. In order to evaluate the influence that individual time-invariant variables have over trade, a second step procedure is applied. In the second step, time-invariant variables are regressed on the estimates of fixed effects, making it possible to see the relevance of these variables (that are observable) on the set of unobservable time-invariant variables, and consequently also on trade value. The result of this two-step procedure provides some useful insights about the relationship of time invariant-variables and trade. Its interpretation and use, particularly on forecasting, is limited and requires special attention.

5.3 FTC Sector and Policy Makers

The following conclusions and recommendations are based on the results of this study. They are aimed at being practical and applicable to FTC sector or used by policy makers to promote the sector.

The study showed that FTC is highly income elastic. SME should diversify its markets in terms of country income growth. The portfolio should include countries with high income growth rate, to take advantage of the effect of this rate over exports, but it should also include countries with income growth rates that are more moderate but sound over time. The approach should focus on reducing any negative impact that the high income growth countries may have, given that these economies are likely to be less stable.

This study reinforces the relevance of building trade relationships over time. The volume of export/import from the previous year will generate positive effects on the present year trade. Once a FTC export firm has penetrated a market, it will be important that this firm consolidates its presence in order to take advantage of the effect of this new market.

SME could explore some of the fixed effects trade relationships that the model showed as positive and significant where trade value is low or even non-existent. For instance Canadian SME could explore Australian markets. According to the model FTC trade between these two countries is expected to be 14 percent higher than the value assigned for those countries that did not trade. Eastern European countries are another good example; FTC trade among them is low, but their trade value could be increased based on time invariant variables.

The U.S. bases its FTC trade on factors that change over time. This capacity could be seen as positive, since the U.S. SME are taking advantage of opportunities that appear over time, however, the U.S. market is also very susceptible to any production shifts, such as the 2002 tart cherries shortage. In this year Poland took advantage to introduce itself to this new market. The U.S. SME needs to develop mechanisms to compensate for the lack of fixed factors such as establishing strategic alliances with companies overseas.

U.S. policy makers should consider creating stronger trade links with the main FTC U.S. markets; this could be made by establishing special trade agreements for this product. In addition, policy makers should promote that FTC producers diversify their exports markers.

5.4 Future Research

Future research on this field could address the following issues that were not covered in this study:

1. Analyze the behavior of time-variant dummy variables in the contexts of the model used in this study. The literature suggests that a model with random effects would produce unbiased and consistent parameters for these sorts of variables.

2. By using simulations it could be possible to establish the reliability of the two step procedure to estimate the effect of time-invariant variables (distance, border).

3. The hypothesis testing procedures for a Tobit model with fixed effects is a field that has not been explored. The adequacy of log-likelihood ratio test is of special interest for GM for specific agri-food products that are estimated by MLE.

ANNEXES

Annex 1. Average yearly value of Frozen Tart Cherry exports/imports of selected countries, 1993 – 2003.

	Value of FTC Exports (000 $US)																	Total
Count.	AUT	AUS	BEL	CAN	DEN	FRA	GER	GRE	HUN	ITA	JAP	MEX	NED	POL	TUR	UK	U.S.	Imports
AUT	-	-	4	185	7	-	-	-	5	-	-	208	8	40	1	-	211	669
AUS	-	-	94	-	6	0	1.540	19	177	6	-	-	316	921	64	10	49	3.202
BEL	92	132	-	52	943	191	1.607	129	667	1	-	8	1.420	4.456	408	142	1.987	12.234
CAN	9	-	132	-	-	3	21	-	3	-	-	-	38	228	22	-	5.472	5.928
DEN	1	4	2.147	-	-	0	386	18	-	-	-	-	278	1.808	69	30	31	4.771
FRA	39	43	5.995	-	137	-	3.495	81	32	65	-	-	2.163	5.380	292	165	863	18.750
GER	4	1.003	57	142	764	579	-	340	3.037	239	-	-	7.598	71.100	3.497	336	1.863	90.560
GRE	-	-	11	-	-	0	123	-	-	-	-	-	4	288	208	19	-	653
HUN	-	2	156	23	-	-	14	-	-	-	-	4	8	113	12	-	-	332
ITA	-	230	-	15	-	328	2.613	122	14	-	-	-	546	899	457	-	119	5.344
JAP	107	-	-	210	-	11	-	-	2	121	-	-	7	-	-	-	1.109	1.566
MEX	6	-	1.192	-	-	-	-	-	-	-	-	-	-	-	-	-	146	1.343
NED	19	34	27	34	137	134	4.793	65	410	77	-	-	-	7.908	339	64	1.449	15.491
POL	-	10	-	18	-	6	189	-	39	8	-	-	21	-	-	13	-	304
TUR	-	-	622	-	-	-	18	-	1	-	-	-	11	-	-	-	-	653
UK	3	13	70	202	2.094	210	911	373	-	5	-	-	1.954	3.437	1.980	-	203	11.456
U.S.	12	5	185	3.168	1	6	8	-	20	-	-	-	130	2.642	39	-	-	6.215
Total Exports	291	1.477	10.692	4.049	4.089	1.469	15.717	1.147	4.407	522	-	220	14.500	99.221	7.389	780	13.502	179.472

Source: Data Service and Information (DSI-Eurostat)

Annex 2. Distance between the capitals of the seventeen countries subject of this study

Count.	Distance in kilometers															
	AUS	BEL	CAN	DEN	FRA	GER	GRE	HUN	ITA	JAP	MEX	NED	POL	TUR	UK	U.S.
AUT	15.905	16.708	16.098	16.025	16.910	16.055	15.195	15.704	16.197	13.165	7.944	16.616	15.550	14.487	16.973	15.936
AUS		913	6.558	864	1.033	520	1.287	219	775	9.124	10.146	931	553	1.603	1.235	7.119
BEL			8.153	767	261	653	2.089	1.132	1.186	9.449	9.244	173	1.160	2.513	322	6.214
CAN				5.902	5.642	6.123	7.738	6.771	6.737	10.314	3.607	5.626	6.569	8.153	5.354	743
DEN					1.026	352	2.135	1.011	1.541	8.689	9.508	622	668	2.295	958	6.512
FRA						879	2.097	1.248	1.121	9.710	9.192	427	1.366	2.597	342	6.162
GER							1.804	690	1.194	8.913	9.724	577	515	2.036	935	6.710
GRE								1.124	1.038	9.506	11.278	2.162	1.601	820	2.393	8.250
HUN									814	9.043	10.361	1.146	545	1.387	1.454	7.335
ITA										9.855	10.250	1.307	1.322	1.712	1.448	7.227
JAP											11.297	9.288	8.577	8.762	9.559	10.907
MEX												9.215	10.175	11.747	8.924	3.031
NED													1.092	2.533	360	1.092
POL														1.641	1.449	7.175
TUR															2.834	8.722
UK																5.894

Source: Great Circle Distances Between Capital Cities web page

Annex 3. Expected export potential expressed as percent of the annual export average

	Export potential (%)																
Countries	AUT	AUS	BEL	CAN	DEN	FRA	GER	GRE	HUN	ITA	JAP	MEX	NED	POL	TUR	UK	U.S.
AUT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AUS	-	-	-	-	-	-	72	-	-	-	-	-	-	-	-	-	-
BEL	-	-	-	-	-	58	28	-	-	-	-	-	82	-	-	-	-
CAN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	363
DEN	41	-	-	-	-	270	-	-	-	-	-	-	-	-	-	-	-
FRA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GER	-	51	-	-	28	34	-	155	-	32	-	-	146	1195	377	-	-
GRE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HUN	-	-	-	-	-	-	-	-	-	-	-	-	-	123	-	-	-
ITA	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
JAP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9
MEX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	-	-
POL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TUR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK	-	-	13	-	-	29	-	-	-	-	-	-	-	7	-	-	-
U.S.	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-

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