Harmonization of Food Regulations and Trade in the Single Market: Evidence from Disaggregated Data

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Abstract

This paper uses a structural gravity model based on Anderson and van Wincoop (2003) to quantify and test the hypothesis that EU harmonization of food regulations increases EU bilateral trade. Using a self-constructed database that identifies processed food products at a detailed level covered by harmonization, our results suggest that bilateral exports subject to harmonized food regulations are 253% greater than bilateral exports not covered by harmonized food regulations for 1998. The paper also estimates a tariff equivalent of trade costs that arises from non-harmonized food regulations which ranges between 73% and 97%. Both of these effects vary across food sub-sectors.

Keywords: Food Regulations, Harmonization, European Integration, Gravity Model

JEL Classification: C31, F15, Q17, Q18

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1. Introduction

One of the most, important factors that has facilitated trade in the food industry between existing European Union (EU) members is the progressive removal of technical barriers to trade (TBT). Previous analysis of the completion of the Single Market in the existing EU15 countries suggests that the removal of TBTs may be of great significance. The European Commission (1997) calculated that during the first phase of the White Paper's food specific program (1985-1986) over 87% of intra-EU trade in manufacturing has been affected by TBTs across EU member states.

The principal mechanisms to eliminate TBTs in the EU have relied on "mutual recognition", whereby a product lawfully produced and sold in any of the EU member states must be given free access to all other EU markets. However, the European Commission has used the harmonization of technical regulations as a strategy to eliminate obstacles to EU trade where the mutual recognition principle failed.

With respect to harmonization of food regulations, the EU has sought to remove TBTs through agreement on a common set of legally binding requirements that are stipulated in the form of detailed directives for a single or group of products. Sometimes referred to as the "old approach", this harmonization approach has mainly been applied to food products or sub-sectors to which the nature of the risk requires extensive product-by-product or even component-by-component legislation and carried out by means of detailed directives. These directives provide a list of a particular industry-specific legislation that is harmonized at the EU level with the aim of achieving an internal market in which products may circulate freely. Trade of products that is regulated by the "old approach" should be subjected to the greatest degree of the Single Market since this approach dates back to the early 70's.

The goal of this paper is to incorporate TBTs in trade models and test the impact of harmonization of technical regulations on bilateral EU trade, with particular reference to the food industry for which compliance to harmonized regulations is severe. This paper fills the gap in the empirical trade literature that has traditionally neglected TBTs in explaining trade flows.

The study uses a self-constructed database, for 1998, described in Brenton *et al*. (2001) that identifies at a very detailed level the products that are covered by relevant harmonization initiatives of technical regulations. In particular, to allow a direct link to the available trade data, EU harmonization initiatives are identified by relevant EU Directives that are translated to the corresponding 8-digit tariff line codes of the European Combined Nomenclature (CN) trade classification. The trade incidence of the harmonization of food regulations is captured by coverage ratios that are constructed for ten processed food sub-sectors of twelve EU countries. Results are reported for the food industry and for each sub-sector separately.

The model we use to measure the impact of the EU harmonized food standards on trade is the so-called gravity model. To place theoretical foundation on our empirical estimations, we follow the gravity model of Anderson and van Wincoop (2003). These authors show that to provide a correct estimate for capturing the effects of trade-enhancing or reducing barriers, a theoretically-grounded structural model is needed. For empirical work, such structural model has the advantage that the functional form of the equation is clearly defined with minimum misspecification. An additional advantage of using a structural model is its ability to calculate a tariff equivalent of other trade barriers that may arise from not harmonizing with food regulations.

The paper is organized as follows. In section 2, we survey some of the previous work. In section 3, we derive the gravity model of international trade and enter the incidence of the harmonization of technical regulations. In section 4, we present some preliminary data results and discuss some methodological issues related to the quantification of food regulations. In section 5, we present and interpret the results of the gravity estimates. In section 6, we compute the trade cost of food regulations expressed in a tariff equivalence. In section 7, we provide some statistical inferences and in the final section we conclude.

2. Related Literature

Several empirical studies that have gauged the impact of regulations and standards on trade, for both manufactured and agricultural goods, have been case studies of particular countries and/or covering particular commodities using data on particular types of regulations. Two issues may emerge from this empirical work. First of all, the level of aggregation of sectors may play a significant role in the degree of information that is revealed from regulations. In the literature, with most studies employing high aggregated data of sectors at the 3 or 4-digit level, it is usually assumed that all trade within a particular sector is affected by regulations while only trade within a sub-category is actually affected. To the extent that the effect of regulations may vary across sub-sectors of a particular sector, important information on its measurement may be hidden when using highly aggregated data. Secondly, studies addressing a cross-country analysis may encounter some problems in the data measurement because methods of administration, requirements and sampling techniques may be different across countries. In our study, we contend that these issues of data aggregation and measurement may be addressed satisfactorily through our analysis. We investigate the consequences of the harmonization of technical barriers to trade with data that are collected at the highest possible level of disaggregation (i.e., 8-digit CN) and, because of dealing with EU harmonization of technical regulations, are uniformly applied to each EU member state.

Based upon the data collection of measuring different types of regulations, we may distinguish the mainstream literature into three categories. In a first category, the studies of Leamer (1990), Harrigan (1993), Trefler (1993) and Haveman and Thursby (2000) use crude indicators of non-tariff barriers (NTB) in investigating their trade impeding effect. The effect of regulations translated into TBTs is implicitly incorporated in the data. The work of Leamer (1990), Harrigan (1993) and Trefler (1993) relies on data of trade barriers that come from a comprehensive inventory of NTBs from the United Nations Commissions on Trade and Development (UNCTAD). This database consists of indicator variables of about 20 different types of NTBs presented at the 8 or 10-digit level tariff line. These various categories of NTBs are then aggregated into four broad categories of price, quantity, quality (e.g., quality standards) and threat (e.g., price monitoring) measures. The results of their investigation are somewhat mixed and may be due to the model specification or the level of data aggregation. For countries member of the Organization of Economic Cooperation and Development (OECD), Leamer (1990) and Harrigan (1993) find that the effect of NTBs on trade is not substantial. In contrast, Trefler (1993) finds that, when treated endogenously in the econometric model, NTBs do have a larger effect on imports of the United States (U.S.). Trefler's view that NTBs, such as regulations, should be set endogenously is rooted in the literature of endogenous protection predicting that trade liberalization plays a role in the setting of domestic NTBs. Haveman and Thursby (2000) construct NTB coverage ratios for agricultural and food products that are collected at the 6-digit Harmonized Tariff System (HS) level. Their primary result indicates that NTBs reduce agricultural and food trade more than tariffs.

In a second category of literature, Swann and Temple (1996) and Moenius (1999) discuss the hypothesis that country-specific standards act like barriers-to-trade while the bilateral harmonization of standards promote trade. Both papers focus on the trade impact of voluntary standards rather than on TBTs as a result of data limitations. In particular, they investigate domestic and institutional standards that are produced by the coordinated efforts of standard setting bodies. Their data come from the Perinorm database that classifies counts of the number of standards by industry at the 3 or 4-digit level.[1] Both papers show evidence that bilaterally shared standards promote trade but fail to find that the numeours country-specific standards act like barriers to trade.

A third category of literature examines the impact of agricultural TBTs. Otskuki *et al.* (2000) suggest that technical regulations in developed countries constitute a considerable obstacle to exports of developing countries and collect data that precisely investigate the impact of the European harmonization of aflatoxin standards on food sub-sectors. This data is obtained from a Food and Agricultural Organization (FAO) survey of mycotoxin standards on food combined with information extracted from an EU Directive. The level of the stringency of food standards is expressed in the maximum allowable contamination. Their results show that EU aflatoxin standards are a major barrier to African exports of dried fruits and nuts. Calvin and Krissoff (1998) estimate the tariff equivalence to technical regulations in the apple sub-sector. They compare cost, insurance and freight CIF prices of U.S. apples in Japan with wholesale prices of Japanese apples. They assume that the price gap consists of the tariff and TBTs equivalent tariff rates. They find that the equivalent tariff rate of technical regulations is higher than the actual tariff rate.

With the exception of these couple recent studies, the impact of TBTs has been neglected in the empirical literature on food trade. For example, both empirical

[1] Perinorm is a bibliographic database that consolidates national and international standards and technical regulations.

models of Henry de Frahan and Tharakan (1999) and van Berkum and van Meijl (1999a) have neglected TBTs as a possible determinant of the European food inter- as well as intra-industry trade. The empirical model of Sun and Koo (2002) drawn from the previous two models has also neglected TBTs to explain intra-industry trade between the U.S. and its major trading partners. In their survey on the application of trade and growth theories to agricultural, van Berkum and van Meijl (1999b) fail to mention trade barriers, in particular TBTs, as key determinants to trade in a sector of which trade is heavily distorted by these barriers.

3. The Gravity Model

In line with the literature examined in the previous section, the general approach to measure the impact of NTBs is based on the so-called gravity model of international trade. Typically in a log-linear form, the model considers that the volume of trade between country pairs is promoted by their economic size or income and constrained by their geographic distances. The advantage of using the gravity model is that many econometric refinements are possible. However, a possible drawback is that the micro-foundations of the gravity model can be easily reconciled from several theoretical underpinnings including the Hecksher-Ohlin, Ricardian technology or monopolistic competition framework.[2]

To place microeconomic foundation on the empirical estimation, we follow the model of Anderson and van Wincoop (2003) who reconcile a theoretical-grounded gravity model that emerges from a general equilibrium model. The interested reader is directed to that paper for an in-depth consideration of the gravity model. Here we simply outline the salient features of the model and incorporate the incidence of the harmonization of technical regulations. To write the standard gravity model in log-linear form, Anderson and van Wincoop (2003) derive the exports of country i to country j of sector k as:[3]

[2] For a recent survey of the gravity theory, see Feenstra (2002, 2003).

[3] The Anderson and van Wincoop (2003) model can easily be extended to a set of many differentiated goods. One of the key features of the Anderson and van Wincoop (2003) model and most other theoretical-derived gravity models (e.g., Deardorff, 1998) is that consumers regards goods as being differentiated by the location of production, known as the "Armington assumption". In a framework, with an assumption that each country is endowed with one good, the standard specification from which a gravity equation usually departs is a constant elasticity of substitution (CES) functional form. In a framework, where the Armington assumption entails that each country is specialized in an unique set of goods, the departing CES functional form assumes that preferences are CES across goods within a sector (i.e., each sector has a distinct aggregator of goods) and assumed to be Cobb-Douglas across

$$\ln x_{ijk} = - \ln y_{wk} + \ln y_{ik} + \ln e_{jk} + (1\text{-}\sigma_k) \ln t_{ijk} - (1\text{-} \sigma_k) \ln P_{ik} - (1\text{-} \sigma_k) \ln P_{jk} \quad (1)$$

where

$$P_{ik} = \sum_i \frac{y_{ik}}{e_{jk}} \left(\frac{t_{ijk}}{P_{ik}} \right)^{1-\sigma k} \quad (2)$$

and y_{wk} is the world output for sector k, y_{ik} is the output in country i for sector k, e_{jk} is the expenditure in country j for sector k, t_{ijk} is the trade cost factor, P_{ik} and P_{jk} are price indices referred to as "multilateral trade resistances" as it depends positively on trading barriers with all trading partners; and σ_k is the elasticity of substitution between foreign sectors k.

In empirical specifications, the unobservable trade cost factor, t_{ijk}, is usually captured by a increasing function of a distance-dependent variable and other trade barriers. We add the incidence of trade-related regulation costs that arise from differences in domestic regulations, *NH*, in the trade costs function and an additional set of other controls, *Z*, which we motivate below. Hence, the trade cost function - usually expressed in its multiplicative form - is written as:

$$t_{ijk} = (d_{ij})^{\delta_k} NH^{(1-\rho_{ijk})} \Pi_g Z_g^{\theta_{ijk}} \quad (3)$$

and in log form:

$$\ln t_{ijk} = \delta_k \ln d_{ij} + (1\text{-}\rho_{ijk}) \ln NH + \Sigma_g \theta_{ijk} \ln Z_g \quad (4)$$

where d_{ij} stands for the bilateral distance between country i and country j, *NH* is the trade cost that arises from differences in food regulations that are not harmonized, ρ_{ijk} takes a value between 0 and 1 and incorporates the reduction in the trade cost that arises from the harmonization of food regulations for each sector k.

Combining equations (1) and (4), the stochastic form of the gravity model for estimation is written as:

$$\ln x_{ijk} = \alpha_{ijk} + \beta_1 \ln y_{ik} + \beta_2 \ln e_{jk} + \tau \ln d_{ij} + \Phi\, \rho_{ijk} + \lambda\, \theta_{ijk} + (\sigma_k -1) \ln P_{ik} + (\sigma_k -1) \ln P_{jk} + \varepsilon_{ijk} \quad (5)$$

sectors. In both frameworks, the solution to the CES functional form subject to a budget constraint yields identical results (with or without the subscript *k*). The reader is referred to the recent work of Anderson and van Wincoop (2004).

where α_{ijk} = (1- σ_k) ln *NH* – ln $y_{w,}$ β_1 and β_2 are unitary, τ = (1- σ_k) δ_k, Φ = (σ_k -1) ln *NH* and λ = (1- σ_k) ln Z. Obviously, the better substitutes countries' goods are for one another, the higher value of σ_k, the greater is the extent to which bilateral trade flows is constrained by trade costs. Given some value for the elasticity of substitution (σ_k), the estimation of equation (5) permits a direct identification of the trade cost that arises from not harmonizing with technical regulations: NH = exp [Φ/(σ_k -1)]. In section 6, we return to this issue.

The empirical specification of the gravity model is based on equation (5) and the general form of our estimating equation is written as:

$$x_{ijk} = \alpha_{ijk} + \beta_1 y_i + \beta_2 y_j + \delta\, d_{ij} + \pi\, X' + \varepsilon_{ijk} \qquad (6)$$

where x_{ijk} is the volume of exports (expressed in logarithm) from country *i* to country *j* of sector *k*, y_i and y_j are approximated by the level of income (logarithm of gross domestic product, GDP) in country *i* and country *j*, respectively, d_{ij} is the distance (expressed in logarithm) between the trading centers of the two countries, ε_{ijk} defines the error term and *X'* is a set of characteristics that include multilateral resistance effects, other geographic characteristics, bilateral prices and the harmonization of food regulations, which are detailed as follows:

Multilateral Resistance Effects or Remoteness: Many authors, in particular Hummels (2001), Rose and van Wincoop (2001), Minondo (2002), Anderson and van Wincoop (2003) and Eaton and Kortum (2003), include importing and exporting country specific dummies, θ_i and θ_j, to correct for multilateral trading resistance factors, P_i and P_j, as defined in equation (2).[4]

As an alternative, we also attempt to capture this multilateral trade resistance effect in a theoretical measure referred to as remoteness and approached by:[5]

[4] The estimation of the stochastic form of equation (5) subjected to a number of condition (depending on the number of countries and sectors) defined in equation (2) requires a non-linear estimator of a complex system. Because such an empirical measurement requires some customs programming, many authors have opted for using country-specific dummies.

[5] The theoretical work of Deardorff (1998) enriches the basic gravity model by including the weighted distance of each country's alternative trading partners in addition to bilateral distances to which he refers as "remoteness". In the more recent gravity literature, the empirical proxy variable for remoteness has been difficult to interpret.

$$R_{ij} = \log\left(\frac{D_{ij}/Y_j}{\sum_{h \neq j} D_{ih}/Y_h} \right) \qquad (7)$$

where the remoteness, R_{ij}, of country *i* to trading partner *j* is given as the ratio of the weighted distance between country *i* and country *j* divided by the weighted average distance between country *i* and all trading partners, *h*, other than *j*, the weights being given by the GDP of the trading partners. This new remoteness measure is expected to give a negative sign since for a given distance from other countries *h*, a greater bilateral distance reduces trade while for a given bilateral distance, a greater distance from other countries increases trade.

Adjacency and Language: The gravity model can easily be appended with various institutional, cultural or historical characteristics. Typically, the gravity studies on European trade add a dummy variable to indicate whether the two countries share a common language and another dummy to indicate whether they share a common land border. In our sample, with the exception of Belgium and Austria, those EU member countries that share a common language also share a common land border. We therefore use an alternative specification of including a dummy, *AL*, for countries sharing a common border and language and a dummy, *AN*, for countries sharing a common border but not a common language. We anticipate that the signs of *AL* and *AN* be positive.

Bilateral Prices: Although generally ignored in the empirical gravity literature - with the exception of Bergstrand (1985, 1989) and Anderson and van Wincoop (2003) - the model should theoretically also take into account price competitiveness because of the heterogeneous competition that characterizes trade flows. We include a measure of competitiveness based on the relative unit labor costs, $rulc_{ijk}$, between the exporting and importing countries, *i* and *j* of sector *k*, namely:

$$rulc_{ijk} = (ulc_{ik}/\sum_h \lambda_h ulc_{hk}) \,/\, (ulc_{jk}/\sum_h \lambda_h \, ulc_{hk}) \qquad (8)$$

where ulc_{ik} and λ_h denote respectively the unit labor cost of country *i* and the share of country *h* in total exports of sector *k* from country *i*. We use the average bilateral trade flows during the period 1995-1998 as the weighting factor. A relative loss in the competitiveness of the exporting country should decrease its exports. We therefore anticipate that the sign of *rulc* be negative.

Coverage Ratio of Harmonized Food Regulations: In our model, the harmonization of food regulations is measured by an export-weighted coverage ratio, ρ_{ijk} , between country *i* and country *j* for sector *k*. We anticipate that the sign of ρ_{ijk} be positive. The construction of the export-weighted coverage ratio as well as priors on its coefficient and measurement are further discussed in section 4.2.

Sector-specific Dummy Variables: In regressions that run over sectors ($k = 1, \ldots, K$), there may still remain some sector specific effects. Therefore, we also include separate dummies for each 3-digit sector, θ_k, to mitigate the potential bias that might arise from differences across sectors.

4. Data and Methodology

4.1. Trade Data

Trade data come from the Comext database of Eurostat and are collected at the 8-digit level of the European CN trade classification and at the 4-digit NACE revision 1 industrial classification.[6] Our sample covers ten NACE sub-sectors: meat (151), fish (152), fruits & vegetables (153), oils & fats (154), dairy & cheese (155), grain (156), sugar (1583) & cacao (1584), tea & coffee (1586), condiments (1587) and miscellaneous food products (bread - 1581, biscuits - 1582, homogenized food - 1588, food n.e.c. - 1589). Our data set comprises bilateral exports for 1998, from each of the individual twelve EU member states excluding Austria and Sweden to each of the fourteen EU member states.[7] Our sample therefore includes 1560 observations (12*13*10).

4.2. Data on the Harmonization of TBTs

To measure the incidence of harmonization of technical regulations in the food industry, we use a self-constructed database that is extracted from previous work of Brenton *et al*. (2001). The product classification of the database follows the detailed CN (1998) classification of the EU to allow a direct link to the trade data. This work

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[6] The Statistical Classification of Economic Activities in the European Community (NACE) is the industrial classification used by the Statistical Office of the European Communities (Eurostat).

[7] Austria and Sweden are omitted due to missing export data to individual EU member states; however exports to the EU as one region are available. Belgium and Luxembourg are treated as a single trading entity. Bilateral trade is recorded in 1000 of euros.

identifies the specific CN product codes that are covered by the relevant harmonization initiatives of technical regulations.[8]

We assume that for those products that are subject to the implementation of the “old approach” remaining trade barriers that may arise from differences in technical regulations are eliminated. There is, however, a possibility that the harmonization process might still leave obstacle to trade. However, we anticipate that remaining barriers for sectors regulated by the old approach are at a minimum. First, “old approach” products should be subjected to the greatest intensity of market integration since this approach dates back to the early 70's. Second, a study of the European Commission (1998) assessing the effectiveness of different instruments to remove TBTs shows that on a five-point scale from low to high, trade of almost all products subject to the “old approach” ranges between a scale of (4) for which *measures are implemented, but some barriers remain*} and a scale of (5) for which *measures are successful and all significant barriers are removed*.

We extract 1284 specific 8-digit CN product codes from the 10 selected NACE food sub-sectors. Table 1 gives the frequency of 8-digit CN product codes covering each of the 10 food sub-sectors as well as the frequency of 8-digit CN product codes being subject to EU harmonization of food regulations within each sub-sector. This table suggests that the number of products by sub-sector that are subject to harmonization vary substantial. For example, the harmonization of regulations in sub-sectors such as oils & fats (154), sugar (1583) & cacao (1584), comprises a high coverage of products while the harmonization of technical regulations in sub-sectors such as most notably meat (151) covers a few number of products. From this table, it is impossible to infer the importance of the harmonization of food technical regulations for each sub-sector because of the missing link between the number of products regulated by harmonization initiatives and trade volumes.

[TABLE 1]

Our model captures the incidence of harmonization of food technical regulations through trade coverage ratios that are calculated for each sub-sector as follows. In the dataset, the incidence of harmonization of TBTs is signaled by a binary indicator variable, ρ_l, taking the value of 1 if the “old approach” applies against the bilateral

[8] Each EU Directive that stipulates a harmonization initiative identifies the scope of products or sub-sectors to which it is pertained.

trade of product l and 0 otherwise. These indicators are aggregated to form a trade coverage ratios, ρ_{ijk}, applicable between country i and country j for sub-sector k. The coverage ratio of the sub-sector k is then defined as: $\rho_{ijk} = \sum_{l \in k} w_{ijl} \rho_l$ where ρ_l = max (ρ_l) and $\sum_{l \in k} w_{ijl} = 1$. If the weights are proportional to the level of bilateral trade, then the coverage ratio is equal to the percentage of a sub-sector covered by the harmonization of technical regulations. Following Leamer (1990), we use home export, weighted coverage ratios for each of the member states.

4.3. Other Data

To this dataset, we add a number of other variables that are necessary to estimate the gravity model. Following the conventional method in the gravity literature, we measure distances between member states with the direct great circle distance between the economic centers, i.e., capital cities. This data is obtained from the web service http://www.indo.com/distance/. Gross capital formation, gross domestic product, population and unit labor costs by sub-sector are obtained from the New Cronos database of Eurostat. For values of unit labor costs unavailable for some sub-sectors in 1998, we approximated the 1998 missing observations by using the average growth rate of observations before and after 1998. In case unit labor cost values are unavailable for consecutive years, we assume that the unit labor cost growth rate at the sub-sector level is identical to the country's growth rate at the total manufacturing level.

4.4. Preliminary Data Analysis

Table 2 shows trade ratios covered by harmonized food regulations by sub-sector and an aggregate of all sub-sectors for each country's exports to the EU-15 in 1998. The country trade coverage ratios indicated in boldface are for those figures that are unusual low or high compared to the EU trade coverage ratio of the sub-sector. By this definition, the first column of Table 2 indicates that 62% of intra-EU trade in food manufactures are affected by harmonized technical regulations. Germany, Greece and Portugal have the highest trade coverage ratios of around 70% while Denmark and Spain have the lowest trade coverage ratios of around 46%. The trade coverage ratios for the remaining countries are close to the level of the EU-15 as a whole.

[TABLE 2]

Among trade coverage ratios for sub-sector and countries, we note substantial variation. Across sub-sectors, the EU trade coverage ratios of oils & fats (154) and sugar (1583) & cacao (1584) are the highest while those of meat (151) are unusual low. It is evident that the importance of these trade coverage ratios also reflects the sub-sectoral composition of exports of each of these countries to the EU. A reasonable observation is that across countries and sub-sectors, the figures suggest that exports of Germany to the individual EU-15 member states are generally characterized by considerable high trade coverage ratios in sub-sectors, notably meat (151), fish (152) and fruits & vegetables (153). Exports of Spain and Portugal also reveal some similarities in their trade coverage ratios with however, some divergences in fruits & vegetables (153) and condiments (1587).

The principal conclusions to be drawn from Table 2 are the overall importance and the variation across countries as well as sub-sectors in the share of trade covered by the harmonization of regulations applied to the food industry. We also recognize that this share is not only affected by differing national regulations but also by the level and composition of export volumes.

To assess the overall importance of EU harmonized food regulations, a comparison between Tables 1 and 2 provides an additional insight on matching the methodological validity of two different indicators of regulations, namely, *trade coverage indicators* (Table 2) and *frequency measures* (Table 1) - defined as the number of products that are regulated by harmonization for a particular food sub-sector. In their survey of methodologies for quantifying NTBs to trade in the agricultural and food sectors, Beghin and Bureau (2001) note that frequency measures are a poor proxy to capture the incidence of regulations. It is evident from these two tables that the importance of harmonized regulations in sub-sectors that ranges from low (meat (151) and fish (152)) to high (oils & fats (154) and sugar (1583) & cacao (1584)) is reflected from the figures in both tables with the exception of condiments (1587). This result suggests a high correlation between these two variables.

5. Econometric Results

5.1. Estimation

The dataset contains some zero-trade values for some countries. Out of the 1560 observations, we recorded 85 zeroes. Among the different procedures to deal with zero values in the dependent variable (Frankel, 1997), we address the censored data for the dependent variable by employing an iterated maximum likelihood estimation of the Tobit model (Greene, 1997). To avoid missing values, in our dataset, the lowest treshold of $ln(x_{ijk})$ and $\ln(\rho_{ijk})$ are taken as zero.

Usually, a theoretical-consistent gravity equation such as model (1) imposes the restriction that the elasticity of exports with respect to both importer's and exporter's incomes be equal to unity, i.e., $\beta_1 = \beta_2 = 1$ (Anderson and van Wincoop, 2003). In our model, we also allow for non-unitary income elasticities by estimating β_1 and β_2. In this case, an endogeneity concern arises between GDP's and exports since the error term, ε_{ijk}, is presumably correlated with y_i and y_j.[9] In all subsequent regression, we replace the predicted values of the GDP's from a regression on several endowment measures that are used as instruments. The set of instruments are (1) the GDP's from the previous two years - this should be sufficiently to capture the variability from cyclical or temporary disturbances, (2) the current population and (3) the gross capital formation, as a proxy variable for investment, from the current and previous two years. The regression of the GDP for each country is estimated for the period 1990 to 1998.

5.2. Results

Table 3 reports the results of the impact of harmonization of food regulations on EU trade using variants of equation (6). First, we estimate a standard form of equation (6) that ignores sector-specific dummies (model a). Second, we add these sector-specific controls to investigate the bias incurred when omitting them (model b). Third, we add the constraint that income elasticities of both the importing and exporting countries are unitary (model c). Finally, we omit the remoteness variable, R_{ij}, and relative unit labor costs, $rulc_{ijk}$, and replace them with country-specific dummies that approximate the multilateral resistance terms (model d).

Our results are largely consistent with our expectations. In Table 3, all the coefficients have the expected signs; their standard errors are relatively low and the overall fit is high. The estimated importing and exporting income elasticities, 0.95 and 0.84 respectively, are very similar to those obtained in the conventional gravity literature (Feenstra, 2002).

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[9] The error term, ε_{ijk} , affects exports of country *i* which in turn are part of income y_i which are equal to imports from country j which are part of y_j. The error term ε_{ijk} affects incomes y_i and y_j.

[TABLE 3]

The coefficients of the distance variable of between - 1.50 to - 1.62 are much larger from previous studies where the consensus estimate is -0.6. Chen (2000) suggests that reported distances that are much lower than the –0.6 general agreed elasticity could be explained by the use of different transport modes. For example, in 1998, 57% of total intra-EU trade went by land whereas most global trade goes by sea (Chen, 2000).

The other geographic variables (R_{ij}, *AL* and *AN*) are also highly significant with the expected signs. On average, a 1% increase in the relative distance to other trading partners (R_{ij}) reduces exports by 22%. Exporting and importing countries that share a common language and border (*AL*) see their bilateral trade to increase by a factor of 1.41 (exp(0.35)) and 1.52 (exp(0.42)) while countries that share a common border but do not share a common language (*AN*) see their bilateral trade to increase by a factor of 1.3 (exp(0.27)) and 1.4 (exp(0.32)). Omitting the remoteness variable, in model (d), increase the impact of *AL* and *AN* on EU bilateral trade.

The strong significance of relative unit labor costs ($rulc_{ijk}$) indicates an important export price determinant. On average, a 1% increase in relative unit labor costs reduces exports by 0.7 %. As a diagnostic check not reported here, values of coefficients in model (d) do not change when we include the relative unit labor costs, $rulc_{ijk}$. Its coefficient of -0.12 is not statistically significant when country-specific control variables are included. This result might be due to a substitution effect between these control dummy variables and the relative unit labor costs that are country-specific in addition to be sector-specific.

We find a significant and positive effect of harmonization of food regulations on EU bilateral trade. This result confirms our hypothesis that harmonization of EU food regulations increases intra-EU trade of food manufactures. The coefficients of the trade coverage ratios range from a low of 1.06 to a high of 1.26. A coefficient of a trade coverage ratio of 1.26 suggests that bilateral exports in sectors subject to EU harmonized food regulations are 253 percent greater than for bilateral exports in sectors not subject to EU harmonized food regulations (2.53 = exp(1.26)-1). The narrow range of these four results suggests that this effect is not overly sensitive to the choice of the functional form of the gravity equation. However, we do observe that model (b) and (d) perform better than the other ones in terms of the overall log-likelihood value reported in the bottom of Table 3.

5.3. Results by Food Sub-Sector

An interesting question that arises from this study of harmonization of food regulations is whether its effect varies across food sub-sectors. This question is partially motivated by the observation in Table 2 that the trade coverage ratios vary considerably across sub-sectors. Table 4 summarizes the results based on sub-sector regressions.

[TABLE 4]

Each sub-sector has 156 observations (12*13). We only report the coefficients of the trade coverage ratio using the gravity specification of model (b) and (d) that are outlined in Table 3 and discussed in the previous section. The results of the coefficients of the trade coverage ratios in Table 4 point one simple conclusion. The effect of harmonization of food regulations is positive for sub-sectors where the harmonization of regulations is highly concentrated (see Table 1). The range of the coefficients from high to low is 5.25 for sugar & cacao (1583 & 1584) and 0.97 for grain mill (156). In sub-sectors were harmonized food regulations are not numerous such as in meat (151), fish (152) and fruits vegetables (153) sub-sectors, the effect of harmonization on EU bilateral trade is curiously negative.

6. Trade Costs of Non-Harmonized Food Regulations

In section 5, we discussed the magnitude of the coefficient on the trade coverage ratio of EU harmonized food regulations in the gravity equation. Recall from section 3 that we can use this coefficient to compute a trade cost that arises from non-harmonized food regulations (*NH*). These trade costs may arise from any other food regulatory policy barriers between EU member states to which EU policy of technical harmonization is not applied.[10] Among others, examples typically to the EU may include general government policies such as public procurement, administrative practices, competition policy, national systems of taxation.

[10] In the context of this paper, these trade barriers are not equivalent to TBTs since for many food sub-sectors (i) the application of the mutual recognition principle is not captured due to data limitation or (ii) country differences in technical regulations are not deemed to be important barriers.

These trade costs can be expressed as if there were a tariff level, referred to as a *tariff equivalent*, which means estimating tariffs that would have the same effect as these other regulatory policy barriers. The estimate of the tariff equivalent of *NH* is defined as: $NH = \exp[\Phi/(\sigma_k - 1)]$, where Φ is the estimated coefficient of the trade coverage ratio of EU harmonized food regulations. This implies that we need an estimate of an elasticity of substitution σ_k between any pair of countries' products in sub-sector *k* to obtain an estimate of trade barriers. We extracted estimates of elasticities of substitution from Surry *et al*. (2002). These authors report Armington elasticities for eleven processed food products imported and consumed in France from which only fish (151), dairy (155) and coffee & tea (1586) are overlapping sub-sectors.[11] In Table 5, we report the tariff-equivalence of trade costs that arise from not harmonizing with food regulations for these three sub-sectors.

[TABLE 5]

We observe that the tariff equivalent is negative for fish (151) and coffee & tea (1586). The negative tariff equivalent for coffee & tea (1586) is due to the low estimate of elasticity of substitution. In contrast, we observe large tariff equivalents of trade barriers for dairy (155) and an aggregate for all food sub-sectors (151-158). Using coefficients of models (b) and (d), the tariff equivalents for dairy (155) are respectively 471% and 171% and those for the entire food sector (151-158) with an arbitrary elasticity of substitution of 2 are respectively 97% and 73%. Messerlin (2001) computes the tariff equivalents of crude NTBs for the EU. For 1999, the tariff equivalents of NTBs amount to 100% for dairy and 5% for the processed food industry.

7. Sensitivity Analysis

The results obtained so far are subject to greater doubt than the standard errors would suggest. However, few studies have addressed the issue at the heart of this paper so that suitable comparisons by which to assess the robustness of the results presented here are not available. Two important sources of doubt remain: outliers and estimator consistency.

7.1. Influential Observations

[11] In the gravity model, the CES for the trade substitution elasticity is derived from Armington (see footnote 2).

The analysis of investigating the residuals, leverage and DFIT values reveals that there are few problems with outliers. First, we test for DFIT values greater than the cut-off value suggested by Belsey *et al.* (1980) who claim that DFIT values greater than 2 times the square root of the number of variables (omitting the dummy variables) divided by the number of observations deserve greater attention.[12] Using this criterion, we detect 43 observations in the total sample from which 16 observations are collided with the exports from Ireland to six different importing countries, 12 observations are collided with the exports from Denmark while the other 15 observations are not centered around one particular country: Belgium (1), France (1), Italy (3), the Netherlands (3), Portugal (2), Spain (1), Sweden (3), United Kingdom (1). Another result that emerges from this analysis is that out of these 43 observations with these largest DFIT values, 21 observations belong to trade of meat products (151). However, no systematic inconsistency appears in trade of meat products for one particular country.

To proceed, we then express the residuals and leverage statistics in averages with normalized standard deviations and aggregate them by exporting country for all sub-sectors and sub-sectors for all exporting countries. The aggregate residuals and leverage statistics do not reveal any inconsistencies among countries except for the residuals of the Netherlands, Ireland, Portugal and Denmark and among sub-sectors except for the residuals of the meat (151) and tea & coffee (1586) sub-sectors. Instead of deleting these observations one at a time and reporting the new results, we omit all the observations contained in a single exporting country or a sub-sector.[13] Because there are four countries and two sub-sectors that deserve more attention, we perform six data adjustments using the gravity specification of model (b) reported in Table 3. The results are encouraging: the coefficient of the trade coverage ratio of harmonized food regulations, ρ_{ijk}, varies between 1.05 and 1.14. When this is measured against the full sample estimate of 1.26 (see Table 3, model b) it is clear that our estimate is not sensitive to the omission of outliers.

7.2. Estimator Consistency

[12] The diagnostic checks are based on model (b) from Table 3.
[13] Note that the omission of a particular observation for one country would lead to changing values for the remoteness variable, R_{ijk} and the relative unit labor cost, $rulc_{ijk}$.

The different gravity model variants that are estimated across countries and sub-sectors impose the restriction that the effect of harmonization of technical regulations on EU bilateral is measured by a constant coefficient, Φ, invariant across exporters and sub-sectors.[14] To test whether this plausible restriction is valid, we decompose Φ into ($\Phi_i + \Phi_k$) and perform several likelihood ratio (LR) tests, which leads to perform four LR tests based on regression model b in Table 3:

(1) Φ_i against Φ

(2) Φ_k against Φ

(3) ($\Phi_i + \Phi_k$) against Φ_i

(4) ($\Phi_i + \Phi_k$) against Φ_k

since we rule out a LR test for testing the relaxation of two constraints against the most restricted model (($\Phi_i + \Phi_k$) against Φ). If test (1) or test (2) - imposing one relaxation of a constraint - is rejected, test (3) or, respectively, test (4) is no longer necessary. From this analysis, the four LR tests do reject the assumption that our restricted model is reasonable. The χ^2 values exceed the critical values in each test.

We therefore replicate the results from Table 3 where we decompose the coefficient of the trade coverage ratio into ($\Phi_i + \Phi_k$). The results of these average coefficients are reported in Table 6. Although there are some variations in the average estimates of ($\Phi_i + \Phi_k$) across the different models, these estimates remain positive. In addition, the average estimates from models (b) and (d) are very close to our benchmark estimates from Table 3.

[TABLE 6]

8. Conclusion

In this paper, we found support for the prediction that the EU harmonization of food regulations has a larger positive effect on intra-EU trade. Our result suggests that EU bilateral exports in sub-sectors subject to EU harmonized food regulations are 253% greater than EU bilateral exports in sub-sectors not subject to EU harmonized food regulations in 1998. These results are not overly sensitive to the choice of the functional form of the gravity equation. Results based on regression by sub-sector

[14] We are not concerned with any importing effect that interacts with the trade coverage ratio of harmonized food regulations. Once a sub-sector or a product is subject and conformed to harmonized regulations, importers can not deter it from their domestic market.

separately suggest that this effect of the harmonization of food regulations varies significantly: the effect of the harmonization of food regulations is positive for sub-sectors where the harmonization of regulations is highly concentrated. This empirical finding suggests that there are positive trade-enhancing effects from the implementation of EU harmonized regulations in the food industry. For EU policy, this provides some evidence to what extent the harmonization approach is successfully removing technical barriers to trade and integrating EU markets in the food industry.

The theoretically funded functional form of the gravity equation allows for the estimation of tariff equivalents of trade costs of not harmonizing with EU food regulations. Subject to the sub-sector elasticity of substitution between origins, these tariff equivalents of regulatory policy barriers can be surprisingly large ranging from 73 to 97% for the whole food industry and 171 to 471% for the dairy sub-sector depending on the functional form of the gravity model. It turns up that this paper has proposed a method to estimate tariff equivalents of trade costs related to regulatory policy barriers in the manufacturing industry from functional forms of gravity models and applied it for food sub-sectors.

This paper has provided a method based on a gravity model to measure the trade impact of harmonizing food regulations among close trade partners. In contrast to the typical gravity-based approach that attributes departures of trade flows from what the gravity model can explain to a mix of country or industry-specific effects, including NTBs, the approach used in this paper explicitly incorporates a measurement of technical regulation harmonization into the gravity model and can, therefore, isolate the specific trade effects of such harmonization. However, like the typical gravity-based approach, this approach is still unsuitable to measure the full welfare impact of harmonizing food regulations. For example, it ignores the effects from corrections for market failures. Consequently, as underscored in the survey of Beghin and Bureau (2001), the tariff equivalent derived from such an approach only reflects the trade volume effects of harmonizing food regulations without welfare interpretations. With still the caveat of not capturing the full welfare effects of NTBs, this paper confirms that combining gravity models with econometric estimates is indeed a promising method for identifying the role of regulations in foregone or, in our case of harmonizing regulations, gained trade as anticipated in the conclusion of the survey of Beghin and Bureau (2001).

As with any other preliminary study, the present study suggests some future projects. Since the estimates of the trade costs that we obtain are very sensitive from assumptions about the elasticity of substitution, one potentially feasible project is to calculate constant elasticities of substitution that emerge from the theoretical grounded gravity equation. Another extension of this paper is to examine whether our results would change under alternative levels of data aggregation. Perhaps, the best, though very data intensive, extension would be to conduct a panel study that evaluates changes of the impact of harmonization technical regulations over time. Such a panel study would require information on the timing of the introduction of a particular harmonized regulation as well as a concordance of CN codes between different time periods.

BIBLIOGRAPHY

Anderson, J. van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. *American Economic Review* 93: 170-193.

Anderson, J. and van Wincoop, E. (2004). Trade costs. NBER working paper no. w10480, National Bureau of Economic Research. Cambridge, MA.

Beghin, J. and Bureau, J.C. (2001). Quantification of sanitary, phytosanitary, and technical barriers to trade for trade policy analysis. Working paper 01-WP-291, Center for Agricultural and Rural Development, Iowa State University.

Belsey, D., Kuh E. and Welsh R. (1980). *Regression Diagnostics*. New York: Wiley.

Bergstrand, J. (1985). The gravity equation in international trade: Some microeconomic foundations and empirical evidence. *The Review of Economics and Statistics* 67: 474-481.

Bergstrand, J. **(**1989). The generalized gravity equation, monopolistic competition and the factors-proportion theory in international trade. *The Review of Economics and Statistics* 71: 143-153.

Brenton, P. Sheehy, J. and Vancauteren, M. (2002). Technical barriers to trade in the European Union: Importance for accession countries. *Journal of Common Market Studies* 39: 265-284.

Calvin L. and Krissoff B. (1998). Technical barriers to trade: A case study of phytosanitary barriers and US-Japanese apple trade. *Journal of Agricultural and Resource Economics* 23: 351-366.

Chen, N. (2000). Intra-national versus international trade in the European Union: Why do national borders matter? Working paper, department of Economics, Université Libre de Bruxelles.

Commission of European Communities (1997). *Processed foodstuffs*. Volume 7 of Sub-series 1 Dismantling of Barriers of The Single Market Review. Office for Official Publication, Luxembourg.

Commission of the European Communities (1998)**.** *Technical Barriers to Trade*. Volume 1 of Sub-series 3 Dismantling of Barriers of The Single Market Review. Office for Official Publication, Luxembourg.

Deardorff, A. (1998). Determinants of bilateral trade: does gravity work in a neoclassical world? In Jeffrey Frankel (eds), *The Regionalization of the World Economy.* University of Chicago Press.

Eaton, J. and Kortum, S. (2001). Technology, geography and trade. *Econometrica* 70: 1741-1779.

Feenstra, R. (2002). The gravity equation in international economics: Theory and evidence. *Scottish Journal of Political Economy* 49: 491-506.

Feenstra, R. (2003). Advanced International Trade: Theory and Evidence. Princeton University Press.

Frankel, J. (1997). Regional trading blocks in the world economic system. Report, Institute for International Economics, Washington D.C.: IIE.

Greene, W. (1997). Econometric Analysis. Prentice Hall, London.

Harrigan, J. (1993). OECD imports and trade barriers in 1983. *Journal of International Economics* 35: 91-111.

Haveman, J. Thursby, J.G. (2000). The Impact of tariff and non-tariff barriers to trade in agricultural commodities: A disaggregated approach. Working paper, Purdue University.

Henry de Frahan, B. and Tharakan, J. (1999). Testing the Determinants of the European Food Trade Flows. Contributed Paper to the 9th Congress of the European Association of Agricultural Economists, Warsaw.

Hummels, D. (2001). Toward a geography of trade costs. Working paper, Purdue University.

Leamer, E. (1990). The structure and effects of tariff and non-tariff barriers in 1983. In Ronald Jones and Anne Krueger (eds.), *The Political Economy of International Trade: Essays in Honor of Robert E. Baldwin*. Cambridge, MA: Blackwell.

Messerlin, P. (2001). Measuring the costs of protection in Europe: European commercial policy in the 2000's. Institute for International Economics, Washington D.C.: IIE.

Minondo, A. (2002). Borders and trade in Europe: A fresh analysis on the extent of the home-bias effect. Working paper, Universidad de Deusto-ESTE, San Sebastian.

Moenius, J. (1999). Information versus product adaptation: The role of standards in trade. Manuscript, University of California, San Diego.

Otsuki, T., Wilson, J. and Mirat, S. (2000). Saving two in a billion: A case study to quantify the trade effect of European food safety standards on African exports", World Bank, Washington D.C.

Rose, A. and van Wincoop, E. (2001). National money as a barrier to trade: The real case for currency union. *American Economic Review Papers and Proceedings* 91: 386-390.

Sun, C. and Koo, W.-W. (2002). Horizontal and Vertical Intra-Industry Trade in the U.S. Food Processing Industry. Agribusiness & Applied Economics report No. 502, Center for Agricultural Policy and Trade Studies, North Dakota State University.

Surry, Y., Herrard N. and Le Roux, Y. (2002). Modelling trade in processed food products: an econometric investigation for France. *European Review of Agricultural Economics* 29: 1-27.

Swann P. and Temple, P. (1996). Standards and trade performance: the UK experience. *The Economic Journal* 106: 1297-1313.

Tinbergen, J. (1962). *Shaping the World Economy: Suggestions for an International Economic Policy*. The twentieth century fund, New York.

Trefler, D. (1993). Trade liberalization and the theory of endogenous protection: An econometric study of US import policy. *Journal of Political Economy* 101: 138-160.

Van Berkum, S. and van Meijl H. (1999a). Horizontal and Vertical Intra-industry Trade in Agricultural and Food Products in the EU. Paper for the Inaugural Conference organised by the European Trade Study group, Rotterdam.

Van Berkum, S. and van Meijl, H. (1999b). The Application of Trade and Growth Theories to Agriculture: A Survey. Paper presented at the International Agricultural Trade Research Consortium Annual Meeting, New Orleans, Louisiana.

Table 1: Frequencies of Products by Food-Sub-Sector Regulated by EU Harmonized Regulations

Food Sub-Sector (Nace Rev. 1)	Description	CN Codes	CN Codes s.t. Harmonization
151	Meat	193	36
152	Fish	242	119
153	Fruits & Veg.	373	289
154	Oils and Fats	82	78
155	Dairy	89	47
156	Grain mill	81	62
1583, 1584	Sugar & Cacao	58	52
1586	Tea & Coffee	15	9
1587	Condiments	35	25
158X[a]	Misc. Foods	116	71
151-158[b]	Food Industry	1284	788

Notes: (a) miscellaneous (158X) consists of the following sub-sectors: bread (1581), biscuits (1582), homogenized food (1588), food n.e.c. (1589). (b) feed (157) is not considered in our analysis because of not being a final good.

Table 2: Trade Coverage Ratios of Food Sub-Sectors subject to EU Harmonized Regulations, 1998 (%)

Member state	All (151-158[a])	Meat (151)	Fish (152)	Fruits & veg. (153)	Oils & Fats (154)	Dairy (155)	Grain mill (156)	Sugar & cacao (1583 & 1584)	Tea & Coffee (1586)	Con-diments (1587)	Misc. Foods (158X[b])
Austria	63.89	11.32	46.02	**75.93**	**49.41**	**83.37**	72.25	99.86	**90.27**	36.69	81.2
Bel./Lux.	65.67	**19.01**	**65.3**	70.29	97.53	61.36	67.51	99.95	**87.81**	10.77	86.9
Denmark	**47.75**	15.77	60.03	**81.53**	99.6	62.23	74.01	97.43	66.92	11.82	78.65
Finland	56.57	15.02	**38.53**	44.08	93.46	49.40	**15.45**	98.02	**99.44**	**47.14**	**98.49**
France	60.56	15.04	45.59	61.06	91.43	73.43	**52.14**	99.5	**41.29**	26.14	79.48
Germany	**71.63**	**19.56**	**72.38**	**78.44**	94.82	80.39	76.16	98.56	68.24	28.45	85.54
Greece	**71.42**	**3.85**	**22.65**	68.4	98.92	70.99	57.27	100	**31.43**	**45.41**	88.06
Ireland	62.04	13.08	42.13	**32.01**	90.71	50.21	**98.22**	99.84	**9.74**	**3.39**	**93.12**
Italy	65.13	**27.82**	**33.13**	63.13	97.69	52.36	**49.55**	99.83	93.12	**4.06**	61.27
Netherlands	56.89	7.23	64.98	48.08	98.5	79.44	**53.38**	99.35	51.62	28.36	90.66
Portugal	**69.39**	8.21	**70.85**	**75.04**	97.45	71.07	75.11	99.93	71.27	**2.76**	**27.89**
Spain	**45.36**	8.21	**68.09**	**24.63**	98.46	54.97	78.2	99.61	66.77	21.5	64.9
Sweden	60.87	14.71	46.06	73.21	97.83	**48.84**	67.96	99.69	54.77	11.41	83.49
UK	58.87	8.44	40.11	69.77	96.25	61.20	**83.89**	98.61	50.12	17.78	86.14
EU15	61.81	14.34	55.67	59.79	96.7	70.84	63.39	99.21	72.74	25.85	86.66

Notes: The coverage ratios indicated in boldface are for those numbers that are the lowest or the largest compared to EU average coverage ratios by each sub-sector. (a) except for feed (157) (b) miscellaneous (158X) consists of the following sub-sectors: bread (1581), biscuits (1582), homogenized food (1588), food n.e.c. (1589).

Table 3: Gravity Estimates of the Impact of the Harmonization of Food Regulations on Intra-EU Trade, 1998

Model	**a**	**b**	**c**	**d**
y_i	.95 (.05)	.94 (.04)	1	1
y_j	.84 (.05)	.84 (.05)	1	1
d_{ij}	-1.62 (.11)	-1.61 (.11)	-1.50 (.09)	-1.56 (.14)
R_{ij}	-.22 (.04)	-.21 (.03)	-.22 (.03)	-
AL	.36 (.16)	.35 (.13)	.42 (.13)	.69 (.23)
AN	.32 (.18)	.32 (.16)	.27 (.16)	.58 (.18)
$rulc_{ijk}$	-.70 (.09)	-.68 (.08)	-.71 (.08)	-
ρ_{ijk}	1.06 (.13)	1.26 (.16)	1.25 (.16)	1.14 (.15)
α_{ijk}	-8.62 (1.51)	-8.88 (1.33)	-10.53 (.71)	-11.34 (.09)
θ_i , θ_j	no	no	no	yes
θ_k	no	yes	yes	yes
$R^{2(a)}$	.85	.90	.83	.91
Log-Likelihood	-3279.86	-3058.75	-3342.17	-2946.14
Observations	1560	1560	1560	1560

Notes: Robust standard errors are in parentheses. (a) R^2 is the squared correlation between actual and predicted values.

Table 4: Gravity Estimates for Trade Coverage Ratio by Food Sub-Sector, 1998

		Model b			Model d		
NACE	**Description**	**Coefficient**	**Std. Error**	**R^{2} (a)**	**Coefficient**	**Std. Error**	**R^{2}(a)**
151	Meat	-2.11	.82	.76	-1.38	.64	.75
152	Fish	-.69	.37	.72	-.66	.31	.77
153	Fruits & Veg.	-1.54	.58	.76	-.15	.56	.74
154	Oils and Fats	4.44	.45	.88	3.21	.55	.82
155	Dairy	1.55	.47	.81	.89	.42	.79
156	Grain mill	.97	.36	.87	1.09	.44	.85
1583, 1584	Sugar & Cacao	5.25	.52	.92	4.8	.49	.87
1586	Tea & Coffee	1.54	.45	.80	1.89	.51	.82
1587	Condiments	.17	.54	.80	-.16	.56	.81
158X[b]	Misc. Foods	2.40	.54	.78	.55	.53	.77
(151-158)[c]	All	.68	.24	.76	.55	.25	.67

Note: Models b and d are analogous to the gravity model specification of models b and d of Table 3. (a) R^2 is the squared correlation between actual and predicted values. (b) miscellaneous (158X) consists of the following sub-sectors: bread (1581), biscuits (1582), homogenized food (1588), food n.e.c. (1589). (c) except for feed (157).

Table 5: Tariff Equivalents of the Cost of EU Non-Harmonized Food Regulations (%)

NACE	Description	Elasticity of Substitution[a]	Model b	Model d
152	Fish	3.46	-24.5%	-23.5%
155	Dairy	1.89	470.6%	171.0%
1586	Tea & Coffee	0.63	-98.4%	-99.4%
(151-158)[b]	All	2.00	97.0%	73.0%

Notes: Models b and d are analogous to the gravity model specification of models b and d of Table 3. (a) trade elasticities are obtained from Surry *et al.* (2000) with the exception of the aggregated food industry (151-158), see text for further details. (b) except for feed (157).

Table 6: Average Coefficient of the Coverage Ratio of EU Harmonized Food Regulations, 1998[a]

Model	a	b	c	d
$(\Phi_i + \Phi_k)\rho_{ijk}$	0.88	1.24	0.86	1.39

Notes: See gravity model specifications in Table 3 for models (a-d).

(a) $[\sum_i \Phi_i]/12 + [\sum_i \Phi_k]/10$