Do Preferential Trade Agreements Increase Members' Agri-food Trade?

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Abstract

This study estimates the effect of a diverse group of 30 PTAs on members' trade of 26 agri-food products categorized into eight commodity sectors for 1990, 1995, 2000 and 2000 using disaggregated trade data for 40 countries and the Heckman selection model. Results show that whether reported zero trade-flows are considered actual or potential affects the size of the estimated PTA impacts. However, irrespective of the true nature of the zero trade-flows, the effects of PTAs are found positive and statistically significant. OLS estimates fall between the Heckman-model-derived conditional and unconditional effects of PTAs.

JEL Code: F130, C180 (Trade Policy; Trade Agreements; Selection Bias)

1.0 Introduction

Many studies have used the gravity equation to estimate the impact of preferential trade agreements (PTAs) on members' trade. At least four generalizations can be drawn from these studies. First, most of the studies use aggregated annual trade values to estimate average effects of PTAs on members trade (Frankel, 1997; Glick and Rose, 2002; Rose and Engel, 2002; Carre`re, 2004; Rose, 2004; Carre`re, 2006; Bair and Bergstrand, 2007). These studies ignore effects of the PTAs across diverse sectors.

Second, studies using disaggregated trade values (Clausing, 2001; Romalis 2005; Mayda and Steinberg, 2007) derive overall results ignoring agri-food. Most of the econometric studies investigating impacts of PTAs on members' agri-food trade (Vollrath, 1998; Hertel, Masters,

and Gehlhar, 1999; Furtan and van Melle, 2004; Vollrath, Hallahan, and Gelhar, 2006; Grant and Lambert, 2008) have not estimated impacts across the agri-food commodity sectors. Zanhiser et al. (2002) estimated the effect of PTAs on disaggregated U.S. agri-food trade, while Sarker and Jayasinghe (2008) estimated the effect of the North American Free Trade Agreement (NAFTA) on the agri-food commodity sectors. These studies with agri-food sector disaggregation are informative but do not provide estimates about the effects of a wide range of PTAs.

Third, studies that estimate the effect of PTAs using disaggregated trade data (Clausing, 2001; Romalis, 2005; Mayda and Steinberg, 2007; Sarker and Jayasinghe, 2008) do not account for zero-trade flows in the analysis. Hence, there is no evidence whether the estimated effects using only nonzero trade flows are valid when zero trade flows are also accounted for in the analysis. More specifically, whether the selection bias due to ignoring zero trade-flows lead to biased (Heckman, 1979; Nijman and Verbeek, 1992; Guillotin and Sevestre, 1994) or higher (Hillberry, 2002) parameter estimates of the effect of PTAs on agri-food trade has not been investigated.

This paper addresses the resulting gap in the existing literature. We estimate the effect of PTAs on agri-food trade across eight commodity sectors using disaggregating trade data for 26 commodities making up these sectors. The analysis accounts for the selection bias while estimating these effects of PTAs for each sector and demonstrates that commodity in addition to other fixed effects should be accounted for in disaggregated agri-food analysis.

The paper is organized into six sections. The next section discusses the econometric model used to estimate the effect of PTAs on agri-food trade accounting for selection bias. Section three presents the data used in the analysis. The effect of PTAs estimated using OLS

ignoring zeros are discussed in the fourth while the same effects estimated after accounting for zero trade flows are presented in section five, followed by conclusions presented in sixth and final section.

2.0 Estimating the effect of PTAs on Agri-food Trade

Gravity equations are an important tool for investigating international trading relationships and have been widely used to estimate the effect of PTAs on the value of trade. Tinbergen (1962) argued that bilateral trade flows are proportional to the product of the economic size of trading partners and the measures of "trade resistance" between them. Trade resistance was measured by Tinbergen by geographic distance and dummy variables used to account for common borders and Commonwealth membership. Anderson (1979) provided the theoretical foundation for the basic gravity equation. The agri-food commodity specific basic gravity equation is specified for selected years as:

$$T_{ijfy} = \gamma_0 \left(dist_{ij}\right)^{\gamma_1} e^{\gamma_2 (DCB_{ij})} e^{\gamma_3 (FTA_{ij})} \left(GDP_{iy}\right)^{\gamma_4} \left(GDP_{jy}\right)^{\gamma_5} \epsilon_{ijfy} \quad (1)$$

where T_{ijfy} is the real value of country *i*'s trade with country *j* in product *f* in year *y* measured in a common currency (real 2000 US$), $dist_{ij}$ is the distance between bilateral trade partners *i* and *j*, DCB_{ij} is a binary variable, which is unity if bilateral trade partners have a common border and zero otherwise, PTA_{ij} is also a binary variable, which is unity if bilateral trade partners have or belong to the same free trade area and zero otherwise, GDP_{iy} (GDP_{jy}) is the real gross domestic product of country *i* (*j*) in year *y* in US$, ϵ_{ijfy} is assumed to be a log-normally distributed error terms and *e* is the natural logarithm base. Studies, including Glick and Rose (2002), Rose and Engel (2002), Carre`re (2004), Rose (2004), Carre`re (2006), Bair and Bergstrand (2007), Sarker and Jayasinghe (2008) and Grant and Lambert (2008) estimate the effect of PTAs on members' trade for a particular year using equation (1) in the logarithmic form augmented mostly with

importing (ψ_i) and exporting (ψ_j) fixed effects. We use disaggregated trade data to estimate sectoral effects; therefore we also add commodity fixed effects (ψ_f). These effects represent the commodities included in a sector and account for the heterogeneity among commodities. The gravity model is:

$$\ln(\mathrm{T}_{ijfy}) = \begin{matrix}\psi_i + \psi_j + \psi_f + \gamma_1 \ln(dist_{ij}) + \gamma_2(DCB_{ij}) + \\ \gamma_3(PTA_{ij}) + \gamma_4 \ln(GDP_{iy}) + \gamma_5 \ln(GDP_{jy}) + \epsilon_{ijfy}\end{matrix} \quad (2)$$

$$t^*_{ijfy} = \begin{matrix}\theta_i + \theta_j + \theta_f + \alpha_1 \ln(dist_{ij}) + \alpha_2(DCB_{ij}) + \\ \alpha_3(PTA_{ij}) + \alpha_4 \ln(GDP_{iy}) + \alpha_5 \ln(GDP_{jy}) + u_{ijfy}\end{matrix}$$

The fixed effect approach is very popular because it is easy to estimate and yields unbiased bilateral trade estimates (Bergstrand et al., 2007). The coefficient $\gamma_3$shows the effect of PTAs on members' trade. The magnitude of the effect is calculated as $[exp(\gamma_3) - 1] \times 100$.

2.1 Selection bias

For empirical analysis, equation (2) includes fixed effects and is log-linearized consequently omitting zero-trade flows from the analysis which can lead to selection bias. Selection bias occurs when a subset of the data is systematically excluded due to a particular attribute. The exclusion of the data can influence the statistical significance of test results and produce biased findings (Heckman, 1979; Hillberry, 2002). This study estimates the effect of PTAs on agri-food trade using equation (2) by OLS and by controlling and correcting for selection bias. It is particularly important to account for zero-trade flows in the context of disaggregated agri-food trade data, where their occurrence is predominant. Haq and Meilke (2009) found that 43 percent of the total observations of agri-food bilateral trade-flows from 1990–2000, across the United States, European Union and Canada are zero and selection bias in estimation of agri-food trade at the commodity level is common.

Zero trade-flows are dealt in five ways: (1) MacCallum (1995) and Frankel (1997) delete the zero trade-flows; (2) MacCallum (1995) replaces the zero trade-flows with small positive numbers; (3) Rose (2000) estimates the regression equation as a Tobit model and censor the zero observations; (4) Linders and De Groot (2006), Bikker and De Vos (1992) use Heckman selection techniques to account for zero trade flows. However, Heckman selection models are not the only way of accounting for the selection bias; or (5) use two-parts modeling (2PM) to account for zero trade flows. Dow and Norton (2003) explain the circumstances under which either Heckman or 2PM are suitable. In case the value of trade is close to zero and rounded-off to zero or it is not reported or missing than value of trade is a potential zero and not actual zero. They suggest that if the outcome of zero is fully observed (i.e. actual zero or corner solution) than there is a selection problem and the 2PM is the right technique to adopt. In case of potential zero, Heckman selection procedures are more appropriate. In the case of trade data, the UN website gives a message of "no data available for these years" (http://comtrade.un.org/db/help/uReadMeFirst.aspx) and it is not possible to ascertain whether zero in this case represents a corner solution or a potential zero. Hence either procedure could be applied based on the assumption that either the trade-flow is an actual or potential zero. In this paper, we apply the Heckman procedure which involves two-step and maximum likelihood techniques and consists of sample selection and outcome equations. The sample selection equation follows a selection rule while the outcome equation investigates the relationship of interest when the outcome is observable.

Consider the following sample selection equation.

$$t^*_{ijfy} = \boldsymbol{\eta}' \boldsymbol{Z_i} + u_i \quad (3)$$

where t^*_{ijfy} is a latent variable and it is not observed but we do observe if countries trade or not, such that $t_{ijfy} = 1$ if $t^*_{ijfy} > 0$ and $t_{ijfy} = 0$ if $t^*_{ijfy} = 0$ and $\boldsymbol{Z_i}$ is a vector of variables that affects t^*_{ijfy}. In the outcome equation (equation 4) let, T_{ijfy} be the natural logarithm of the value of country *i*'s trade with country *j* of commodity sector *f* in year *y* and $\boldsymbol{X_i}$ is the vector of independent variables determining T_{ijfy}, so

$$T_{ijfy} = \boldsymbol{\gamma}' \boldsymbol{X_i} + \varepsilon_i \quad (4)$$

The errors u_i and ε_i, *i*=1,...,*N* have a bivariate normal distribution with zero means, standard derivation of σ_u and σ_ε and correlation ρ. Greene (2003) and Hoffmann and Kassouf (2005) show that

$$E\left[T_{ijfy} | t_{ijfy} = 1\right] = \boldsymbol{\gamma}' \boldsymbol{X_i} + \rho \sigma_\varepsilon \lambda_i(\alpha_u) \quad (5)$$

where the function $\lambda_i(\alpha_u) = \frac{\phi\left(\frac{\boldsymbol{\eta}' \boldsymbol{z}}{\sigma_u}\right)}{\Phi\left(\frac{\boldsymbol{\eta}' \boldsymbol{z}}{\sigma_u}\right)}$ is the inverse Mills ratio (IMR), ϕ is the standard normal density function and Φ is the cumulative standard normal distribution function. Equation (5) estimates the expected values of T_{ijfy} when trade is observed (i.e. greater than zero). Greene (2003) shows that due to the correlation between $\boldsymbol{X_i}$ and IMR a least squares regression of T_{ijfy} on $\boldsymbol{X_i}$, omitting $\lambda_i(\alpha_u)$ produces an inconsistent estimator of $\boldsymbol{\gamma}'$. Also, standard regression techniques assume that ρ=0, thus eliminating the IMR in equation (5) and producing biased estimation results if the IMR is non-zero. A least square regression would yield consistent estimators only if the expected value of the error is known and included in the regression — as the Heckman selection model does (Hoffmann and Kassouf, 2005).

Let X_{f_k} denote regressors common to both the selection and outcome equations and consider $\rho \sigma_\varepsilon = \beta_\lambda$, then the marginal effect for the regressor is

$$\frac{\partial E\left[T_{ijfy}|t_{ijfy}=1\right]}{\partial X_{f_k}} = \boldsymbol{\gamma}_{f_k} - \frac{\eta_{f_k}}{\sigma_u}\beta_\lambda\lambda_i(\alpha_u)[\lambda_i(\alpha_u)-\alpha_u] = \boldsymbol{\gamma}_{f_k} - \frac{\eta_{f_k}}{\sigma_u}\beta_\lambda\delta_i \quad (6)$$

where $\delta_i = \lambda_i(\alpha_u)[\lambda_i(\alpha_u)-\alpha_u]$. The marginal effect given in equation (6) is composed of a change in the value of trade (T_{ijfy}) due to a change in X_f for the bilateral trade partners participating in trade. Hence, this effect is conditional on the bilateral partners trading non-zero values of product *f* and it is called the conditional marginal effect. Greene (2003) and Hoffmann and Kassouf (2005) also derive the conditional marginal effect for a common binary variable. Assume now that $Z_{f_k}$is a binary variable. Let $\bar{z}_0$ be the vector of explanatory variables in the participation equation with X_{f_k} equal to zero, and all other variables at their mean values and $\bar{z}_1$ be the same vector when X_{f_k} is equal to one. Then the change in the IMR ($\Delta\lambda$) for $\bar{z}$, when it moves from $\bar{z}_1$ to $\bar{z}_0$ is $\frac{\phi\left(\frac{\eta'\bar{z}_1}{\sigma_u}\right)}{\Phi\left(\frac{\eta'\bar{z}_1}{\sigma_u}\right)} - \frac{\phi\left(\frac{\eta'\bar{z}_0}{\sigma_u}\right)}{\Phi\left(\frac{\eta'\bar{z}_0}{\sigma_u}\right)}$. Hence, the conditional marginal effect for the binary variable is

$$\frac{\partial E\left[\Delta T_{ijfy}|t_{ijfy}=1\right]}{\partial Z_{f_k}} = \boldsymbol{\gamma}_{f_k} + \beta_\lambda\Delta\lambda \quad (7)$$

Hoffmann and Kassouf (2005) also derive the unconditional marginal effects for the continuous and binary variables that are common to both the selection and outcome equations. For a logarithmic specification of the gravity model, the unconditional marginal effect for a continuous variable that is common to both the selection and outcome equations is

$$\frac{\partial E\left[T_{ijfy}\right]}{\partial X_{f_k}} = \gamma_{f_k} - \frac{\eta_{f_k}}{\sigma_u}\beta_\lambda\delta_i + \left[\Phi\left(\frac{\eta' Z_i}{\sigma_u}\right)\right]^{-1}\phi\left(\frac{\eta' Z_i}{\sigma_u}\right)\frac{\eta_{f_k}}{\sigma_u} \quad (8)$$

Using the analogy of Hoffmann and Kassouf (2005), the first two terms on the right hand side show the change in trade of agri-food product *f* for the trading partners having observable trade flows (i.e. more than zero) while the last term shows the effect due to a change in the probability

of the trading partners being involved in trade. Similarly, the unconditional marginal effect for the binary variable that is common to both the selection and outcome equations is

$$\frac{\partial E\left[\Delta T_{ijfy}\right]}{\partial \mathrm{Z}_{f_k}} = \boldsymbol{\gamma}_{f_k} + \beta_\lambda \Delta\lambda \; + \Delta ln\Phi(-\alpha_u) \tag{9}$$

where $\Delta ln\Phi(-\alpha_u) = ln\Phi\left(\frac{\boldsymbol{\eta}'\boldsymbol{z_1}}{\sigma_u}\right) - ln\Phi\left(\frac{\boldsymbol{\eta}'\boldsymbol{z_0}}{\sigma_u}\right)$. Since the marginal effects vary for each observation we calculate these effects at the mean values.

The existing studies that use the Heckman selection model specify the selection and outcome equations as a gravity equation. Linder and de Groot (2006) use a gravity equation for both the selection and outcome equations. Hillberry (2002) estimates a more restricted variant of the gravity model in which an independent selection equation is estimated. Helpman et al. (2008) estimate selection and outcome equations that include only the variables that affect trade costs. Hence, the exact specification of the selection and outcome equations differ across studies but a gravity equation incorporating the variables determining trade costs are generally incorporated in the selection equation.

3.0 Data

Disaggregated agri-food trade data is downloaded from the UN Comtrade data base for four separate years: 1990, 1995, 00 and 2005. The data consists of 40 countries including 17 high income countries, 12 upper middle income countries, eight lower middle income countries and three low income countries[1]. The data is organized by the Standard International Trade

[1]High income countries include Canada, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, USA, United Kingdom; upper middle income countries include Argentina, Brazil, Chile, Costa Rica, Malaysia, Mexico, Poland, Romania, Russian Federation, South Africa, Turkey and Venezuela; lower middle income countries include China, Colombia, Egypt, Indonesia, Peru, Philippines, Sri Lanka and Thailand and low income countries include India, Pakistan and Uruguay.

Classification (SITC), revision 3, at the three-digit level. Data on 26 commodities is categorized into eight agri-food product sectors as follows:

i. Meat sector: products having SITC codes 011 (bovine meat), 012 (other meat), 016 (meat and edible meat offal, salted, in brine, dried or smoked) and 017 (meat and edible meat offal, prepared or preserved);
ii. Dairy sector: 022 (milk and cream), 023 (butter) and 024 (cheese and curd);
iii. Unmilled cereals: 041 (wheat), 042 (rice), 043 (barley), 044 (maize), 045 (other cereals);
iv. Processed cereals: 046 (wheat meal), 047 (cereal meal) and 048 (cereal preparation);
v. Fish: 034 (fresh, chilled, frozen fish), 035 (salted, dried and smoked fish) 036 (crustaceans, molluscs etc), 037 (fish prepared, preserved);
vi. Fruits: 057 (fresh fruits), 058 (preserved fruits) and 059 (fruit juice);
vii. Vegetables: 054 (fresh vegetables), 056 (processed vegetables);
viii. Sugar: 061 (sugar, molasses, honey) and 062 (sugar confectionary).

The number of observations for all sectors and years are 224640 out of which 142,523 (63.5 percent) were zeros . Unmilled cereal sector has the highest proportion (80 percent) of zeros while vegetables sector has the lowest proportion (38 percent) of zeros.

For the explanatory variables, gross domestic product (GDP) in US dollars come from the World Bank's World Development Indicators. The dummy variable representing membership of trade partners in a preferential trade agreement is developed from Baier and Bergstrand (2007). The study includes 30 PTAs, including bilateral trade agreements[2]. Distance is measured

[2] These are European Union (EU), European Free Trade Association (EFTA), Latin American Free Trade Agreement/Latin American Integration Agreement, Central American Common Market, Economic Customs Union of the Central African States, EU–EFTA Agreement/European Economic Area, Australia–New Zealand Closer Economic Relations, US–Canada, Central Europe Free Trade Agreement, EFTA–Hungary, EFTA–Poland, EFTA–Romania, EU–Hungary, EU–Poland (1994), North American Free Trade Agreement (NAFTA), Costa Rica–Mexico, EU–Romania, Group of Three, Mercado Comun del Sur (Mercosur), Andean Community, Mercosur–

as the air distance between country *i* and *j*. Estimates of distance and common border are taken from the *Centre d'EtudesProspectives et'Informations Internationales* (CEPII).

4.0 The effect of PTAs on Member's Trade: Ignoring Selection Bias

Tables 1 to 4 provide OLS results of equation (2) for the eight agri-food product sectors using only the positive trade flows. All of the models fit the data well and their explanatory power ranges from 34.9 percent for un-milled cereals in 1990 to 61.6 percent for vegetables in 1990. The F-statistics are significant at the 99 percent level for all the estimated models implying that the hypothesis that all of the coefficients of the regression models except the intercept are zero, is consistently rejected.

The importer and exporter fixed effects are included in the models to account for multilateral resistance terms and to control for other omitted country and product-specific factors. These fixed effects are tested with the null hypothesis that their joint effects are zero. Importer, exporter and product-specific fixed effects are statistically significant for all the sectors. These results imply that estimating the models without these fixed effects would have produced biased estimates. The estimated models also include distance and a dummy variable to represent common borders. Theoretically, an increase in distance between trading partners decreases trade and hence a negative coefficient is anticipated. Countries with a common border trade more and a positive sign is anticipated on this dummy variable. Results of the estimated models for all the sectors show that these variables have the expected signs and are statistically significant.

The effects of PTAs on members' agri-food trade across the eight commodities sectors estimated by OLS using the positive (non-zero) trade-flows in gravity equation are also given in

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Chile, Canada–Chile, Association of Southeast Asian Nations (ASEAN), Hungary–Turkey, India–Sri Lanka, Romania–Turkey, Romania–Turkey, Mexico–Chile, EU–Mexico, Poland–Turkey.

tables 1 to 4. Results indicate that the effect of PTAs on agri-food trade in all eight sectors using positive (non-zero) trade-flows is positive and statistically significant in the selected years. Bair and Bergstrand (2007) while estimating the effect of similar set of PTAs included in this study, found negative effect of PTAs on members' aggregate trade for the years 1980, 1990 and 2000 using a similar specification of the gravity model. Bair and Bergstrand (2007) also introduced the reported zeros by assigning a vale of "1" before taking logs (MacCallun's (1995) approach) but their results of negative effects of PTAs did not change. Hence, our results for agri-food trade differ from these findings. Although based only on the observed positive trade flows, our results are consistent with the theoretical expectation that PTAs will increase trade among members, even if they also have trade diverting effects.

The positive effects of PTAs on agri-food trade derived from the estimated coefficients range from a low of 51.3 percent for fish in 1990 to a high 175.1 percent for processed cereals in 2000. The effect of PTAs on members' agri-food trade is generally stable over time within each of the eight sectors. The effects of a PTA on trade of processed cereals and dairy among members has been consistently more than double the level compared to countries that are not both members of a PTA. PTA members' trade of processed cereals was 1.6 times more in 1995 to 1.8 times more in 2000, while it was 1.2 times more in 2005 to 1.3 times in 2000 for dairy sector. Thus, the results from OLS estimation using only the positive trade flows show that the effects of PTAs on members' agri-food trade are positive, statistically significant, vary across sectors and are relatively large for all the sectors across the four years. The next section estimates the effects of PTAs on members' trade using the same data set but accounting for the selection bias i.e. include zero trade-flows in the analysis.

5.0 The effect of PTAs Accounting for Selection Bias

The Heckman selection model is estimated using his maximum likelihood (ML) method accounting for heteroscedasticity. The results of the Heckman ML procedure for both the outcome and selection equations are reported in tables 5 to 8. These tables show that all the models are statistically significant at the 99 percent level of significance. The Wald test is used to test the null hypothesis that rho (ρ) equals zero i.e. the selection and outcome equations are independent of each other. Failure to reject the null hypothesis indicates no selection bias while rejection of the null implies that OLS produces biased estimates. The analysis accepts the null hypothesis only for vegetables sector for the years 1995 to 2005 and sugar sector for the years 2000 and 2005. Hence, for these two sectors, Heckman estimates converge to OLS estimates in these years (ignoring zeros does not produce selection bias) while for the rest of the sectors the use of the Heckman procedure is appropriate. The Heckman ML procedure estimates the arc hyperbolic tangent of rho i.e. $ln\left(\frac{1+\rho}{1-\rho}\right)$ and the natural logarithm of sigma (σ). Tables 5 to 8 show that natural logarithm of σ is statistically significant for all the sectors while arc hyperbolic tangent of rho is statistically insignificant only for the vegetables sector for the 1995 and 2000. Again, the statistically significant estimates of ρ and σ show that ignoring zero trade flows produce biased estimates. Jayasinghe, et. al. (2010), Disdier and Marette, (2010) and Helpman et al. (2008) find similar results.

The results from the Heckman procedure show that all the estimated coefficients have the expected signs. Rejection of the null hypothesis that the combined effect of the fixed effects is zero occurs for all the sectors in both the selection and outcome equations. Again, the implication is that ignoring these effects in the empirical analysis would produce biased estimates. Distance is negative and statistically significant in all the models indicating that an

increase in distance between trading partners decrease trade (outcome equations) and decreases the participation of countries in trade (selection equations) . The effect of distance on the value of trade is consistently elastic for processed cereals, vegetables, fish and sugar sectors. In the selection and outcome equations, both common border and PTAs have positive sign and are statistically significant for all the commodity sectors. Similarly, exporter's income is statistically significant for all the commodity sectors in both the selection and outcome equations while importer's income is statistically insignificant only for dairy, un-milled and processed cereals in the outcome equations for the years 1995 and 2000. In all the cases, importer's or exporter's income have positive effect on trade when they are statistically significant. These results for the outcome equation implies that increase in importer's and exporter's income increases trade while for selection equation these results imply that an increase in importer's (or exporter's) income increases their participation in trade.

5.1 Comparison of OLS with Conditional and Unconditional Marginal Effects

Selection bias can be a serious issue while estimating the effect of PTAs on members' trade. Ignoring it leads to biased estimates. While, the Heckman ML estimation procedure provides control for the selection bias, the estimates are not directly interpretable. For interpreting these results, we present presents the conditional and unconditional marginal effects and compares these with the OLS estimates. The conditional marginal effect of a variable shows its effect on the value of trade for countries participating in trade in that sector. The unconditional marginal effect adds the effect of the increase in the proportion of countries engaged in trade to the conditional marginal effect (equation 8). Hence, unconditional marginal effects are larger than the conditional marginal effects. The conditional marginal effects are comparable to OLS estimates since they are based only on non-zero trade flows (Hoffmann and Kassouf, 2005). OLS estimates and conditional marginal effects are comparable from both

statistical (their significance) and economic (their magnitude) perspectives. First, all the estimates of the effects of PTA using OLS and Heckman's conditional marginal effects are statistically significant. Hence, the selection bias does not affect outcome of the test of the null hypothesis.

Comparing the conditional and OLS effects of the PTAs on members' trade from an economic perspective shows that OLS estimates are consistently higher than conditional estimates (Figure 1). However, with the exception of processed cereals and meat for all years, dairy for the year 1990 and un-milled cereals for the year 1995, the difference between the conditional and OLS effects of the PTAs on members' trade are under ten percent. The effect of PTAs on processed cereals trade obtained using OLS and Heckman's conditional estimates are more divergent. For processed cereals sector, OLS estimates are consistently elastic as compared to inelastic conditional estimates. The effect of PTAs on members' trade for the years 1990, 1995, 2000 and 2005 estimated using OLS for processed cereals are respectively, 46, 45, 53 and 51 percent higher than their corresponding conditional estimates. In the case of meat for all the years, OLS estimates of the effect of PTAs are higher than conditional estimates by 15 percent. Overall, ignoring zeros in the analysis leads to higher estimates of the PTAs effect on members' trade for some commodity sectors and for some years resulting in changes in the economic interpretation of the estimates.

5.2 Conditional versus Unconditional Estimates

Comparing the conditional and unconditional estimates of the PTA effects from economic perspective shows that with the exception of dairy, processed cereals and fish sectors, the unconditional estimates are consistently elastic as compared to their corresponding conditional estimates, which are inelastic (Tables 9 to 12). Out of the 32 unconditional parameter estimates, 20 estimates for which the conditional estimates were inelastic become elastic and only in the

case of 12 estimates (dairy, processed cereals and fish sectors), the economic interpretation of the effect of PTAs on members trade remained inelastic. Because all estimated selection effects are positive, in all the cases the unconditional estimates for the PTA variables are higher than the conditional estimates (Figure 2). There are no sign or statistically significance reversals.

The analysis showed that PTAs have a positive and significant impact on trade between PTA members whether zeros are included or excluded from the analysis. However, ignoring zeros in estimating the effect of PTAs on members agri-food trade leads to biased estimated. Including zeros in the analysis, on the other hand, effect the magnitude of parameters as most of the unconditional estimates are elastic. However, the test of the null hypothesis is consistent to whether zeros are included or omitted from the analysis. From policy view point, the magnitude of the estimate of PTA's effect on members' trade is very important. Therefore, the choice of estimation technique and the assumption about the nature of zero trade flows is critical in estimating the effect of PTAs on members' trade.

6.0 Conclusion

This study estimates the effect of a diverse group of 30 PTAs on members' trade of 26 agri-food products categorized into eight commodity sectors for 1990, 1995, 2000 and 2000 using disaggregated trade data. Our analysis contributes in a number of ways. First, it includes a large set of PTAs. Second, the effect of these PATs is estimated for a large group of commodities categorized into eight agri-food sectors. Third, the effect of PTAs is estimated with and without controlling for selection bias. Fourth, conditional and unconditional estimates of the effect of PTAs are derived and compared with estimates derived using OLS.

Results show that previous estimates of the effect of PTAs on members' trade estimated ignoring zero trade flows could be biased as result of selection bias. The study includes zero

trade flows in the analysis and controls for selection bias using Heckman maximum likelihood procedure. The conditional and unconditional estimates derived using the Heckman estimates show that conditional estimates are generally lower and unconditional estimates are higher than OLS estimates. Hence, previous studies have estimated a larger effect of the PTAs on members' trade while using OLS. However, the direction of the test of null hypothesis of the effect of PTAs was found consistent across the estimation procedures. The general outcome of positive and statistically significant effect of PTAs on members' trade remains consistent whether zero agri-food trade flows are included or excluded from the analysis.

References

Anderson, J. (1979). A theoretical foundation for the gravity equation. *The American Economic Review* 69:106–16

Bair, S., and Bergstrand, J. (2007). Do free trade agreements actually increase member' international trade? . *Journal of International Economics , 71,* 72–95.

Bikker, J. A. and de Vos, F. (1992). An international trade flow model with zero observations: an extension of the tobit model. *Brussels Economic Review* 135: 379–404.

Carre`re, C e`line (2004). African regional agreements: impact on trade with or without currency unions. *Journal of African Economies*, 13(2): 199–239

Carre`re, Ce`line. (2006). Revisiting the effects of regional trade agreements on trade flows with proper specification of the gravity model. *European Economic Review,* 50: 223–247

Center for International Business(CIB). 2007. Trade Agreement Database. Tuck School of Business, Dartmouth College, Hanover, NH (http://cibresearch.tuck.dartmouth.edu/).

Clarete, Ramon; Edmonds, Christopher and Wallack, Jessica. (2002). Asian Regionalism and Its Effects on Trade in the 1980s and 1990s. Asian Development Bank.

Clausing, K.A. (2001). Trade creation and trade diversion in the Canada – United States free trade agreement. *Canadian Journal of Economics*, 34(3): 677–696

Disdier, A. and Marette, S. (2010). The Combination of Gravity and Welfare Approaches for Evaluating Nontariff Measures. *American Journal of Agricultural Economics* 92:713-726.

Dow, W. H., & Norton, E. C. (2003). Choosing between and interpreting the Heckit and two-part models for corner solutions. *Health Services & Outcome Research Methodology, 4*, 5–18.

Frankel, J. A. 1997. *Regional trading blocs in the world economic system*. Washington D.C.: Institute for International Economics.

Furtan,W.H., and B.M. van Melle. (2004). Canada's agricultural trade in North America: Do national borders matter? *Review of Agricultural Economics*, 26(3):317–31.

Glick, Reuven and Rose, Andrew. (2002). Does currency union affect trade? The time series Evidence. *European Economic Review*, 2002, 46(6): 1125–5 1.

Grant, Jason and Lambert, Dayton. (2008). Do regional trade agreements increase members' agricultural trade? *American Journal of Agricultural Economics*, 90(3):765–782

Greene, W. H. (2003). *Econometric analysis*. 5th ed. Upper Saddle River, NJ: Prentice Hall.

Guillotin, Y. and Sevestre, P. (1994). Estimations de fonctions de gains sur donne´es de panel: Endoge´neite´ du capital humain et effets de la se´lection. Economies et Pre´vision 116, 119–135.

Haq, Zahoor and K. Meilke. (2009). The role of income and non-homothetic preferences in trading differentiated food and beverages: The case of Canada, the United States, and selected EU Countries". *Canadian Journal of Agricultural Economics*, 57:169-89

Heckman, J. (1979). Sample selection bias as a specification error. *Econometrica , 47* (1), 153–162.

Helpman, E., M. Melitz and Y. Rubinstein. 2007. Estimating trade flows: Trading partners and trading volumes. http://www.nber.org/papers/w12927 (accessed on February 15, 2007).

Hertel, T.W., Masters, W.M., and Gehlhar, M.. (1999). Regionalism in world food markets: Implications for trade and welfare." In G.H. Peters and V.T. von Braun, eds. Food Security, Diversification and Resource Management: Refocusing the Role of Agriculture. Aldershot, UK: Ashgate Press.

Hillberry, R. H. (2002). Aggregation Bias, compositional change and the border effect. *The Canadian Journal of Economics , 35*, 517–30.

Hoffmann, R. and Kassouf, L. (2005). Deriving conditional and unconditional marginal effects in log earnings equations estimated by Heckman's procedure. *Applied Economics* 37:1303–1311.

Jayasunghe, S., Beghin, C. and Moschini, G. (2010). Determinants of world demand for U.S. corn seeds: the role of trade costs. *American Journal of Agricultural Economics* 92:999-1010.

Linders, G. M. and H. L. F. de Groot. 2006. Estimation of the gravity equation in the presence of zero trade flow. Tinbergen Institute Discussion Paper No. TI 2006-072/3.

Maccallum, J. T. 1995. National borders matter: Canada-U.S. regional trade partners. *American Economic Review* 85: 615–23.

Mayda, Anna and Steinberg, Chad. (2007). Do South-South trade agreements increase trade? Commodity-Level: Evidence from COMESA. African and Research Departments, IMF Working Paper Number WP/07/40

Mukherji, Indra. (2004). South Asian Free Trade Area and Indo-Pakistan Trade. *The Pakistan Development Review,* 43(4): 943–958

Nijman, T. and Verbeek, M. (1992). Incomplete panels and selection bias. In: Matyas, L., Sevestre, P. (Eds.), The Econometrics of Panel Data. Kluwer, Dordrecht, pp. 262–302.

Romalis, J., (2005). NAFTA's and CUSFTA's impact on North American trade. NBER Working Papers 11059, National Bureau of Economic Research, Inc.

Rose, Andrew and Engel, Charles. (2002). Currency unions and international integration. *Journal of Money, Credit and Banking*, 34(4): 1067–1089.

Rose, Andrew. (2004). Do we really know that the WTO increases trade? *The American Economic Review,* 94 (1): 98–114.

Rose, A. K. 2000. One money, one market: The effect of common currencies on trade. *Economic Policy* 15: 8–45.

Sarker, R. and Jayasinghe, S. (2008). Regional trade agreements and trade in agrifood products: Evidence from the European Union from gravity modeling using disaggregated data. *Review of Agricultural Economics,* 37: 93–104.

Vollrath, T.L., C.B. Hallahan, and M.J. Gehlhar. (2006). Consumer demand and cost factors shape the global trade network in commodity and manufactured goods. *Canadian Journal of Agricultural Economics*, 54(4):497–511.

Vollrath, T. (1998). RTAs and Agricultural Trade: A Retrospective Assessment." Regional Trade Agreements and U.S. Agriculture. M.E. Burfisher and E.A. Jones eds., AER No. 771, U.S. Department of Agriculture, Economic Research Service, Washington, DC.

Zahniser, S., Pick, D., Pompelli, G., and Gehlhar, M. J. (2002). Regionalism in the western hemisphere and its impact on U.S. agricultural exports: A gravity-model analysis. *American Journal of Agricultural Economics,* 84(3):791–7.

Table 1: Regression results for meat and dairy sectors (real 2000 US dollars) using least squares

	Meat				Dairy			
	1990	1995	2000	2005	1990	1995	2000	2005
Log of Distance	-0.803***	-0.837***	-0.833***	-0.857***	-0.827***	-0.849***	-0.865***	-0.990***
	(0.0642)	(0.0638)	(0.0637)	(0.0638)	(0.0849)	(0.0802)	(0.0785)	(0.0806)
Common Border	1.216***	1.215***	1.238***	1.194***	1.239***	1.189***	1.254***	1.295***
	(0.141)	(0.140)	(0.139)	(0.141)	(0.183)	(0.180)	(0.171)	(0.172)
Preferential Trade Agreement	0.921***	0.890***	0.849***	0.773***	1.213***	1.234***	1.272***	1.163***
	(0.117)	(0.116)	(0.116)	(0.116)	(0.152)	(0.148)	(0.142)	(0.146)
Log of GDP_i	0.391**	0.387**	0.422**	0.401**	0.603**	-0.0861	0.0235	0.535**
	(0.160)	(0.159)	(0.162)	(0.160)	(0.195)	(0.192)	(0.199)	(0.190)
Log of GDP_j	0.386**	0.363**	0.348**	0.384**	0.392**	0.935***	0.858***	0.442**
	(0.158)	(0.157)	(0.161)	(0.159)	(0.192)	(0.192)	(0.198)	(0.187)
Fixed Effects								
Importing Country	18.3***	20.2***	21.3***	21.0***	12.2***	13.7***	15.7***	15.8***
Exporting Country	38.2***	38.1***	40.1***	39.4***	28.9***	32.1***	35.2***	33.1***
Commodity	279.5***	280.0***	2777.7***	284.0***	119.0***	167.4***	198.6***	173.1***
Summary Statistics								
Number of Observations	5214	5336	5344	5339	3281	3539	3657	3720
Adj. R-Squared	0.488	0.486	0.485	0.488	0.507	0.504	0.522	0.511
AIC	23938.3	24552.4	24605.9	24584.6	14887.9	16064.7	16471.7	17079.0
F-Statistics	72.1***	73.2***	73.5***	74.1***	49.5***	51.6***	55.7***	57.2***

Heteroskedasticity-consistent standard errors are given in parentheses. Variables are statistically significant at *0.1, **0.05 and ***0.001 levels

Table 2: Regression results for un-milled and processed cereals sectors (real 2000 US dollars) using least squares

	Un-milled Cereals				Processed Cereals			
	1990	1995	2000	2005	1990	1995	2000	2005
Log of Distance	-0.760***	-0.759***	-0.824***	-0.859***	-1.121***	-1.155***	-1.153***	-1.201***
	(0.0753)	(0.0743)	(0.0743)	(0.0742)	(0.0566)	(0.0562)	(0.0559)	(0.0566)
Common Border	0.617***	0.610***	0.641***	0.588***	1.465***	1.449***	1.560***	1.471***
	(0.166)	(0.163)	(0.164)	(0.166)	(0.145)	(0.146)	(0.143)	(0.146)
Preferential Trade Agreement	0.923***	0.917***	0.870***	0.835***	0.909***	0.854***	0.895***	0.883***
	(0.142)	(0.140)	(0.140)	(0.140)	(0.112)	(0.112)	(0.111)	(0.111)
Log of GDP_i	0.368*	0.133	0.137	0.431**	0.378**	0.163	0.193	0.310**
	(0.196)	(0.194)	(0.195)	(0.193)	(0.149)	(0.149)	(0.148)	(0.146)
Log of GDP_j	0.607***	0.804***	0.818***	0.546**	0.534***	0.680***	0.673***	0.610***
	(0.179)	(0.178)	(0.179)	(0.178)	(0.140)	(0.139)	(0.139)	(0.138)
Fixed Effects								
Importing Country	12.3***	13.5***	13.2***	14.0***	21.8***	22.4***	23.2***	23.7***
Exporting Country	34.9***	34.9***	35.5***	36.8***	29.1***	28.0***	28.2***	27.2***
Commodity	28.1***	45.1***	25.0***	21.6***	1405.1***	1397.4***	1490.4***	1494.5***
Summary Statistics								
Number of Observations	5082	5187	5236	5283	4877	5006	5076	5190
Adj. R-Squared	0.349	0.363	0.355	0.357	0.599	0.586	0.593	0.594
AIC	25017.2	25534.0	25834.4	26162.6	21112.9	21760.7	22009.0	22704.1
F-Statistics	39.0***	13.6***	41.7***	44.7***	105.7***	104.2***	109.1***	110.5***

Heteroskedasticity-consistent standard errors are given in parentheses. Variables are statistically significant at *0.1, **0.05 and ***0.001 levels

Table 3: Regression results for vegetables and fish sectors (real 2000 US dollars) using least squares

	Vegetables				Fish			
	1990	1995	2000	2005	1990	1995	2000	2005
Log of Distance	-1.174***	-1.181***	-1.133***	-1.169***	-0.985***	-0.984***	-0.975***	-0.987***
	(0.0554)	(0.0539)	(0.0553)	(0.0570)	(0.0469)	(0.0458)	(0.0455)	(0.0459)
Common Border	0.981***	1.002***	1.126***	1.105***	1.037***	1.048***	1.070***	1.054***
	(0.167)	(0.163)	(0.168)	(0.175)	(0.113)	(0.111)	(0.112)	(0.112)
Preferential Trade Agreement	0.423***	0.483***	0.572***	0.597***	0.333***	0.339***	0.352***	0.375***
	(0.113)	(0.111)	(0.109)	(0.114)	(0.0938)	(0.0919)	(0.0917)	(0.0915)
Log of GDP_i	0.697***	0.812***	0.602***	0.555***	0.510***	0.532***	0.521***	0.498***
	(0.134)	(0.135)	(0.142)	(0.137)	(0.118)	(0.116)	(0.119)	(0.118)
Log of GDP_j	0.239*	0.0306	0.286**	0.398**	0.286**	0.285**	0.303**	0.293**
	(0.131)	(0.134)	(0.141)	(0.136)	(0.119)	(0.117)	(0.120)	(0.119)
Fixed Effects								
Importing Country	16.5***	14.8***	15.4***	16.6***	34.8***	33.6***	37.3***	37.0***
Exporting Country	81.0***	79.7***	76.7***	74.9***	55.7***	57.0***	57.9***	59.5***
Commodity	28.9***	57.6***	27.7***	44.1***	237.4***	285.0***	290.5***	331.0***
Summary Statistics								
Number of Observations	4021	4268	4392	4455	7866	8152	8270	8346
Adj. R-Squared	0.616	0.615	0.598	0.586	0.474	0.480	0.479	0.481
AIC	16492.4	17537.8	18291.5	18957.5	35193.1	36384.6	36976.9	37430.3
F-Statistics	108.2***	113.0***	108.3***	105.4***	103.7***	111.6***	112.4***	111.8***

Heteroskedasticity-consistent standard errors are given in parentheses. Variables are statistically significant at *0.1, **0.05 and ***0.001 levels

Table 4: Regression results for sugar and oilseeds (real 2000 US dollars) using least squares

	Fruits				Sugar			
	1990	1995	2000	2005	1990	1995	2000	2005
Log of Distance	-0.838***	-0.864***	-0.883***	-0.913***	-1.473***	-1.490***	-1.445***	-1.447***
	(0.0453)	(0.0452)	(0.0461)	(0.0457)	(0.0784)	(0.0766)	(0.0759)	(0.0762)
Common Border	1.227***	1.221***	1.182***	1.200***	0.729**	0.775***	0.891***	0.974***
	(0.123)	(0.121)	(0.123)	(0.122)	(0.234)	(0.225)	(0.222)	(0.225)
Preferential Trade Agreement	0.540***	0.501***	0.503***	0.455***	0.682***	0.472***	0.545***	0.592***
	(0.0921)	(0.0927)	(0.0925)	(0.0921)	(0.143)	(0.141)	(0.138)	(0.140)
Log of GDP_i	0.344**	0.520***	0.393***	0.270**	0.505***	0.491***	0.390**	0.538***
	(0.113)	(0.115)	(0.116)	(0.113)	(0.141)	(0.141)	(0.136)	(0.138)
Log of GDP_j	0.640***	0.357**	0.554***	0.759***	0.674***	0.576***	0.744***	0.615***
	(0.115)	(0.117)	(0.119)	(0.116)	(0.136)	(0.135)	(0.130)	(0.133)
Fixed Effects								
Importing Country	33.7***	30.8***	30.3***	32.9***	7.9***	8.1***	9.8***	9.7***
Exporting Country	76.3***	76.7***	76.6***	80.9***	17.0***	18.4***	16.1***	20.4***
Commodity	168.2***	177.2***	195.2***	281.0***	31.0***	12.1**	3.4*	12.9**
Summary Statistics								
Number of Observations	6942	7242	7378	7441	3612	3855	3965	4096
Adj. R-Squared	0.540	0.530	0.528	0.534	0.529	0.524	0.520	0.508
AIC	29587.3	31197.8	31869.4	32277.1	15212.4	16328.9	16825.3	17836.4
F-Statistics	109.6***	107.9***	110.3***	116.8***	46.5***	48.2***	50.4***	50.3***

Heteroskedasticity-consistent standard errors are given in parentheses. Variables are statistically significant at *0.1, **0.05 and ***0.001 levels

Table 5: Estimates of the Heckman selection model for meat and dairy sectors (real 2000 US dollars) estimated using ML procedure

Variable	Meat				Dairy			
	1990	1995	2000	2005	1990	1995	2000	2005
	Outcome Equation							
Log of Distance	-0.952***	-0.994***	-0.978***	-1.002***	-0.954***	-0.953***	-0.948***	-1.089***
	(0.0644)	(0.0642)	(0.0641)	(0.0641)	(0.0843)	(0.0799)	(0.0778)	(0.0802)
Common Border	1.256***	1.247***	1.277***	1.239***	1.293***	1.236***	1.294***	1.325***
	(0.140)	(0.139)	(0.137)	(0.139)	(0.180)	(0.177)	(0.169)	(0.170)
Preferential Trade Agreement	1.032***	0.995***	0.966***	0.904***	1.322***	1.324***	1.355***	1.259***
	(0.117)	(0.116)	(0.115)	(0.116)	(0.150)	(0.146)	(0.140)	(0.145)
Log of GDP_i	0.441**	0.436**	0.453**	0.470**	0.658***	-0.0503	0.0547	0.593**
	(0.159)	(0.158)	(0.161)	(0.159)	(0.194)	(0.190)	(0.197)	(0.188)
Log of GDP_j	0.521***	0.496**	0.492**	0.500**	0.471**	1.007***	0.917***	0.490**
	(0.158)	(0.157)	(0.161)	(0.158)	(0.190)	(0.189)	(0.196)	(0.185)
Arc Hyperbolic Tangent of Rho	0.278***	0.277***	0.266***	0.270***	0.216***	0.177***	0.151***	0.159***
	(0.0260)	(0.0257)	(0.0255)	(0.0250)	(0.0260)	(0.0274)	(0.0256)	(0.0261)
ln(sigma)	0.878***	0.883***	0.883***	0.884***	0.835***	0.834***	0.815***	0.859***
	(0.0117)	(0.0114)	(0.0116)	(0.0115)	(0.0145)	(0.0138)	(0.0138)	(0.0142)
Importing Countries	1676.0***	3566.3***		1719.3***	1002.1***	1066.7***	1156.3***	1175.9***
Exporting Countries	3533.3***		3677.1***	3658.5***	2819.2***	2894.9***	3068.2***	3013.8***
Commodity	1969.0***	1976.7***	1951.8***	1928.9***	656.7***	780.5***	1021.1***	1275.8***
Total Observations	20280	20280	20280	20280	14040	14040	14040	14040
Censored Observations	15066	14944	14936	14941	10759	10501	10383	10320
LR Test	7045.2	7156.5	7119.5	7211.0	4786.7	4479.0	4971.0	4790.8
Wald Chi	114.4***	115.9***	108.7***	116.6***	69.1***	41.9***	34.6***	37.0***
	Selection Equation							
Log of Distance	-0.466***	-0.492***	-0.471***	-0.468***	-0.499***	-0.523***	-0.525***	-0.556***
	(0.0252)	(0.0253)	(0.0254)	(0.0255)	(0.0317)	(0.0315)	(0.0317)	(0.0315)
Common Border	0.371***	0.338***	0.375***	0.405***	0.451***	0.448***	0.470***	0.405***

	(0.0789)	(0.0797)	(0.0792)	(0.0803)	(0.0932)	(0.0926)	(0.0935)	(0.0936)
Preferential Trade Agreement	0.529***	0.512***	0.557***	0.596***	0.551***	0.557***	0.609***	0.616***
	(0.0507)	(0.0507)	(0.0505)	(0.0504)	(0.0595)	(0.0593)	(0.0595)	(0.0585)
Log of GDP_i	0.195***	0.192***	0.132**	0.245***	0.281***	0.230**	0.236**	0.377***
	(0.0573)	(0.0576)	(0.0586)	(0.0581)	(0.0705)	(0.0716)	(0.0749)	(0.0729)
Log of GDP_j	0.418***	0.395***	0.457***	0.368***	0.305***	0.355***	0.352***	0.218**
	(0.0564)	(0.0565)	(0.0575)	(0.0567)	(0.0682)	(0.0696)	(0.0723)	(0.0695)

Heteroskedasticity-consistent standard errors are given in parentheses. Variables are statistically significant at *0.1, **0.05 and ***0.001 levels

Table 6: Estimates of the Heckman selection model for un-milled and processed cereals sectors (real 2000 US dollars) estimated using ML procedure

Variable	Un-milled Cereals				Processed Cereals			
	1990	1995	2000	2005	1990	1995	2000	2005
	Outcome Equation							
Log of Distance	-0.942***	-0.937***	-0.996***	-1.043***	-1.207***	-1.254***	-1.243***	-1.286***
	(0.0768)	(0.0759)	(0.0760)	(0.0762)	(0.0568)	(0.0564)	(0.0563)	(0.0569)
Common Border	0.722***	0.710***	0.729***	0.690***	1.531***	1.519***	1.625***	1.520***
	(0.164)	(0.162)	(0.162)	(0.164)	(0.144)	(0.145)	(0.143)	(0.146)
Preferential Trade Agreement	1.047***	1.038***	0.993***	0.963***	0.953***	0.893***	0.939***	0.922***
	(0.141)	(0.139)	(0.139)	(0.139)	(0.111)	(0.111)	(0.110)	(0.110)
Log of GDP_i	0.438**	0.178	0.181	0.499**	0.423**	0.194	0.217	0.363**
	(0.195)	(0.193)	(0.194)	(0.193)	(0.148)	(0.147)	(0.147)	(0.145)
Log of GDP_j	0.687***	0.901***	0.912***	0.627***	0.621***	0.795***	0.785***	0.682***
	(0.178)	(0.177)	(0.178)	(0.177)	(0.138)	(0.138)	(0.138)	(0.136)
Arc Hyperbolic Tangent of Rho	0.221***	0.215***	0.206***	0.219***	0.216***	0.227***	0.216***	0.197***
	(0.0312)	(0.0302)	(0.0302)	(0.0310)	(0.0229)	(0.0230)	(0.0233)	(0.0221)
ln(sigma)	1.039***	1.039***	1.043***	1.054***	0.738***	0.748***	0.742***	0.760***
	(0.0110)	(0.0108)	(0.0108)	(0.0110)	(0.0121)	(0.0117)	(0.0115)	(0.0117)

Importing Countries	1130.4***	1163.2***	1164.5***	1211.7***	1744.7***	1745.3***	1758.1***	1805.1***
Exporting Countries	3274.1***	3243.1***	3312.1***	3335.5***	2164.9***	2086.3***	2081.8***	2112.3***
Commodity	961.3***	1011.1***	880.0***	852.0***	4437.5***	4581.0***	4535.8***	4336.5***
Total Observations	26520	26520	26520	26520	14040	14040	14040	14040
Censored Observations	21438	21333	21284	21237	9163	9034	8964	8850
LR Test	3148.6	3486.9	3279.9	3267.2	10635.4	10477.5	10532.3	10722.5
Wald Chi	50.4***	50.8***	46.3***	50.0***	89.16***	97.6***	85.9***	79.4***
	Selection Equation							
Log of Distance	-0.500***	-0.506***	-0.511***	-0.510***	-0.439***	-0.481***	-0.459***	-0.462***
	(0.0220)	(0.0219)	(0.0220)	(0.0219)	(0.0280)	(0.0282)	(0.0278)	(0.0277)
Common Border	0.527***	0.520***	0.501***	0.530***	0.614***	0.619***	0.598***	0.533***
	(0.0617)	(0.0617)	(0.0618)	(0.0621)	(0.0918)	(0.0925)	(0.0910)	(0.0902)
Preferential Trade Agreement	0.387***	0.389***	0.409***	0.393***	0.355***	0.304***	0.347***	0.331***
	(0.0423)	(0.0421)	(0.0421)	(0.0418)	(0.0589)	(0.0583)	(0.0579)	(0.0568)
Log of GDP_i	0.170***	0.127**	0.127**	0.176***	0.256***	0.173**	0.145**	0.304***
	(0.0509)	(0.0508)	(0.0517)	(0.0510)	(0.0654)	(0.0639)	(0.0651)	(0.0643)
Log of GDP_j	0.270***	0.299***	0.309***	0.258***	0.518***	0.606***	0.627***	0.473***
	(0.0493)	(0.0491)	(0.0500)	(0.0491)	(0.0664)	(0.0649)	(0.0665)	(0.0653)

Heteroskedasticity-consistent standard errors are given in parentheses. Variables are statistically significant at *0.1, **0.05 and ***0.001 levels

Table 7: Estimates of the Heckman selection model for vegetables and fish sectors (real 2000 US dollars) estimated using ML procedure

Variable	Vegetables				Fish			
	1990	1995	2000	2005	1990	1995	2000	2005
	Outcome Equation							
Log of Distance	-1.186***	-1.193***	-1.139***	-1.178***	-1.071***	-1.080***	-1.072***	-1.088***
	(0.0554)	(0.0540)	(0.0552)	(0.0572)	(0.0469)	(0.0457)	(0.0455)	(0.0460)
Common Border	0.986***	1.006***	1.128***	1.109***	1.042***	1.053***	1.077***	1.061***

	(0.165)	(0.161)	(0.166)	(0.174)	(0.113)	(0.112)	(0.112)	(0.112)
Preferential Trade Agreement	0.426***	0.486***	0.575***	0.601***	0.352***	0.363***	0.381***	0.414***
	(0.112)	(0.110)	(0.108)	(0.113)	(0.0936)	(0.0918)	(0.0916)	(0.0916)
Log of GDP_i	0.701***	0.821***	0.607***	0.565***	0.563***	0.622***	0.602***	0.589***
	(0.132)	(0.134)	(0.141)	(0.136)	(0.117)	(0.114)	(0.118)	(0.117)
Log of GDP_j	0.261**	0.0465	0.295**	0.408**	0.335**	0.307**	0.337**	0.330**
	(0.130)	(0.132)	(0.140)	(0.135)	(0.118)	(0.116)	(0.119)	(0.118)
Arc Hyperbolic Tangent of Rho	0.0445*	0.0418	0.0231	14.71***	0.185***	0.208***	0.213***	0.223***
	(0.0265)	(0.0266)	(0.0264)	(0.720)	(0.0225)	(0.0214)	(0.0215)	(0.0213)
ln(sigma)	0.611***	0.616***	0.644***	3.327***	0.814***	0.811***	0.815***	0.823***
	(0.0148)	(0.0141)	(0.0142)	(0.468)	(0.00881)	(0.00864)	(0.00867)	(0.00871)
Importing Countries	1675.1***	1436.9***	1383.3***	1390.1***	3507.8***	3337.2***	3437.6***	3451.7***
Exporting Countries	4169.9***	4137.5***	4087.7***	4030.1***	4583.1***	4748.8***	4770.0***	4863.1***
Commodity	35.4***	118.0***	30.9***	220.1***	1357.3***	1576.8***	1809.4***	2343.3***
Total Observations	7800	7800	7800	25172.9	20280	20280	20280	20280
Censored Observations	3779	3532	3408	3345	12414	12128	12010	11934
LR Test	9062.1	9556.3	9123.1	8599.2	8013.6	9210.0	9305.0	9312.5
Wald Chi	2.83*	2.5	0.8	1.2	67.8***	95.2***	98.6***	109.7***
	Selection Equation							
Log of Distance	-0.429***	-0.510***	-0.475***	-0.474***	-0.485***	-0.504***	-0.501***	-0.502***
	(0.0386)	(0.0428)	(0.0418)	(0.0418)	(0.0237)	(0.0242)	(0.0242)	(0.0244)
Common Border	0.553***	0.599***	0.558***	0.619***	0.306***	0.311***	0.311***	0.316***
	(0.142)	(0.157)	(0.156)	(0.156)	(0.0796)	(0.0814)	(0.0810)	(0.0810)
Preferential Trade Agreement	0.321***	0.354***	0.440***	0.456***	0.215***	0.224***	0.256***	0.274***
	(0.0889)	(0.0936)	(0.0930)	(0.0933)	(0.0491)	(0.0497)	(0.0497)	(0.0494)
Log of GDP_i	0.427***	0.550***	0.538***	0.641***	0.440***	0.591***	0.546***	0.518***
	(0.0949)	(0.0881)	(0.0948)	(0.0954)	(0.0539)	(0.0539)	(0.0553)	(0.0551)
Log of GDP_j	0.761***	0.628***	0.634***	0.531***	0.213***	0.0610	0.106**	0.134**
	(0.0940)	(0.0879)	(0.0942)	(0.0950)	(0.0526)	(0.0523)	(0.0539)	(0.0535)

Heteroskedasticity-consistent standard errors are given in parentheses. Variables are statistically significant at *0.1, **0.05 and ***0.001 levels

Table 8: Estimates of the Heckman selection model for fruits and sugar sectors (real 2000 US dollars) estimated using ML procedure

Variable	Fruits				Sugar			
	1990	1995	2000	2005	1990	1995	2000	2005
	Outcome Equation							
Log of Distance	-0.858***	-0.888***	-0.898***	-0.930***	-1.502***	-1.517***	-1.448***	-1.445***
	(0.0453)	(0.0453)	(0.0462)	(0.0458)	(0.0785)	(0.0762)	(0.0756)	(0.0758)
Common Border	1.237***	1.235***	1.191***	1.209***	0.725**	0.776***	0.891***	0.974***
	(0.122)	(0.120)	(0.122)	(0.122)	(0.233)	(0.224)	(0.220)	(0.223)
Preferential Trade Agreement	0.544***	0.506***	0.508***	0.460***	0.693***	0.484***	0.546***	0.591***
	(0.0915)	(0.0922)	(0.0919)	(0.0916)	(0.141)	(0.140)	(0.137)	(0.139)
Log of GDP_i	0.362**	0.548***	0.408***	0.293**	0.509***	0.502***	0.390**	0.537***
	(0.112)	(0.114)	(0.116)	(0.112)	(0.139)	(0.139)	(0.135)	(0.137)
Log of GDP_j	0.667***	0.379**	0.572***	0.776***	0.716***	0.611***	0.748***	0.613***
	(0.114)	(0.116)	(0.118)	(0.115)	(0.134)	(0.134)	(0.129)	(0.132)
Arc Hyperbolic Tangent of Rho	0.0690**	0.0785***	0.0507**	0.0575**	0.0734**	0.0680**	0.00657	-0.00341
	(0.0210)	(0.0216)	(0.0224)	(0.0223)	(0.0313)	(0.0332)	(0.0350)	(0.0321)
ln(sigma)	0.701***	0.724***	0.730***	0.739***	0.664***	0.678***	0.681***	0.738***
	(0.0102)	(0.00988)	(0.0102)	(0.0102)	(0.0162)	(0.0153)	(0.0155)	(0.0158)
Importing Countries	2886.8***	2559.7***	2478.9***	2550.3***	975.0***	861.6***	903.5***	862.0***
Exporting Countries	4645.0***	4722.3***	4714.8***	4856.5***	1352.5***	1426.0***	1366.5***	1561.3***
Commodity	528.8***	547.9***	666.1***	1185.1***	60.0***	102.5***	5.5**	209.3***
Total Observations	14040	14040	14040	14040	7800	7800	7800	7800
Censored Observations	7098	6798	6662	6599	4188	3945	3835	3704
LR Test	9997.3	9761.2	9384.3	9753.2	3508.9	3639.3	3447.1	3676.2
Wald Chi	10.8***	13.2**	5.14**	6.7**	5.5**	4.2**	0.1	0.1

	Selection Equation							
Log of Distance	-0.389***	-0.414***	-0.402***	-0.414***	-0.559***	-0.596***	-0.590***	-0.633***
	(0.0273)	(0.0282)	(0.0283)	(0.0286)	(0.0393)	(0.0419)	(0.0419)	(0.0430)
Common Border	0.428***	0.470***	0.506***	0.485***	0.302**	0.431**	0.367**	0.309*
	(0.0927)	(0.0960)	(0.0956)	(0.0965)	(0.143)	(0.153)	(0.154)	(0.165)
Preferential Trade Agreement	0.211***	0.215***	0.248***	0.247***	0.373***	0.418***	0.476***	0.392***
	(0.0607)	(0.0611)	(0.0615)	(0.0617)	(0.0923)	(0.0949)	(0.0966)	(0.0954)
Log of GDP_i	0.515***	0.602***	0.547***	0.617***	0.281**	0.376***	0.255**	0.365***
	(0.0652)	(0.0635)	(0.0664)	(0.0663)	(0.0924)	(0.0836)	(0.0884)	(0.0944)
Log of GDP_j	0.498***	0.346***	0.420***	0.382***	0.773***	0.694***	0.806***	0.681***
	(0.0633)	(0.0618)	(0.0650)	(0.0648)	(0.0943)	(0.0842)	(0.0911)	(0.0952)

Heteroskedasticity-consistent standard errors are given in parentheses. Variables are statistically significant at *0.1, **0.05 and ***0.001 levels

Table 9: Conditional and unconditional marginal effects for meat and dairy sectors

Variable	Meat				Dairy			
	1990	1995	2000	2005	1990	1995	2000	2005
	Conditional							
Log of Distance	-0.705***	-0.733***	-0.738***	-0.760***	-0.752***	-0.781***	-0.803***	-0.921***
	(0.065)	(0.065)	(0.064)	(0.064)	(0.085)	(0.080)	(0.079)	(0.081)
Common Border	1.063***	1.022***	1.090***	1.035***	1.116***	1.093***	1.169***	1.206***
	(0.146)	(0.145)	(0.143)	(0.146)	(0.184)	(0.181)	(0.171)	(0.172)
Preferential Trade Agreement	0.759***	0.731***	0.691***	0.607***	1.106***	1.147***	1.194***	1.079***
	(0.119)	(0.118)	(0.118)	(0.118)	(0.151)	(0.148)	(0.142)	(0.146)
Log of GDP_i	0.337**	0.334**	0.386***	0.343**	0.544**	-0.126	-0.010	0.480**
	(0.158)	(0.158)	(0.161)	(0.158)	(0.193)	(0.191)	(0.197)	(0.188)
Log of GDP_j	0.299*	0.286*	0.259	0.309**	0.348*	0.890***	0.820***	0.424**
	(0.157)	(0.157)	(0.161)	(0.158)	(0.191)	(0.191)	(0.197)	(0.185)
	Unconditional							

Log of Distance	-0.988***	-1.094***	-1.049***	-1.046***	-0.900***	-1.076***	-1.106***	-1.197***
	(0.052)	(0.056)	(0.054)	(0.055)	(0.052)	(0.060)	(0.060)	(0.060)
Common Border	1.085***	1.035***	1.148***	1.229***	1.172***	1.295***	1.404***	1.228***
	(0.230)	(0.235)	(0.240)	(0.247)	(0.260)	(0.281)	(0.294)	(0.285)
Preferential Trade Agreement	1.430***	1.425***	1.548***	1.645***	1.376***	1.562***	1.758***	1.763***
	(0.153)	(0.156)	(0.157)	(0.159)	(0.166)	(0.181)	(0.188)	(0.184)
Log of GDP_i	0.419***	0.433***	0.318**	0.541***	0.521***	0.412**	0.446**	0.790***
	(0.111)	(0.116)	(0.118)	(0.117)	(0.117)	(0.134)	(0.143)	(0.142)
Log of GDP_j	0.843***	0.836***	0.954***	0.782***	0.539***	0.776***	0.782***	0.478***
	(0.110)	(0.116)	(0.117)	(0.115)	(0.113)	(0.131)	(0.139)	(0.135)

Variables are statistically significant at *0.1, **0.05 and ***0.001 levels.

Table 10: Conditional and unconditional marginal effects for un-milled and processed cereals sectors

Variable	Un-milled Cereals				Processed Cereals			
	1990	1995	2000	2005	1990	1995	2000	2005
	Conditional							
Log of Distance	-1.060***	-1.085***	-1.091***	-0.782***	-0.685***	-0.686***	-0.752***	-0.782***
	(0.057)	(0.057)	(0.056)	(0.075)	(0.076)	(0.075)	(0.075)	(0.075)
Common Border	1.338***	1.317***	1.441***	0.428**	0.461**	0.460**	0.497**	0.428**
	(0.147)	(0.148)	(0.144)	(0.169)	(0.169)	(0.165)	(0.166)	(0.169)
Preferential Trade Agreement	0.837***	0.789***	0.828***	0.766***	0.852***	0.848***	0.801***	0.766***
	(0.112)	(0.112)	(0.111)	(0.140)	(0.142)	(0.141)	(0.141)	(0.140)
Log of GDP_i	0.337**	0.133	0.170	0.409**	0.351*	0.115	0.121	0.409**
	(0.148)	(0.147)	(0.147)	(0.192)	(0.194)	(0.192)	(0.194)	(0.192)
Log of GDP_j	0.447***	0.582***	0.578***	0.495**	0.549**	0.753***	0.765***	0.495**
	(0.140)	(0.140)	(0.140)	(0.177)	(0.178)	(0.177)	(0.178)	(0.177)
	Unconditional							
Log of Distance	-1.459***	-1.684***	-1.653***	-0.907***	-0.846***	-0.890***	-0.897***	-0.907***

	(0.076)	(0.082)	(0.083)	(0.037)	(0.036)	(0.037)	(0.038)	(0.037)
Common Border	2.518***	2.641***	2.650***	1.235***	1.197***	1.216***	1.162***	1.235***
	(0.348)	(0.359)	(0.359)	(0.174)	(0.170)	(0.174)	(0.171)	(0.174)
Preferential Trade Agreement	1.329***	1.209***	1.393***	0.888***	0.858***	0.893***	0.927***	0.888***
	(0.196)	(0.199)	(0.201)	(0.102)	(0.102)	(0.104)	(0.104)	(0.102)
Log of GDP_i	0.778***	0.532**	0.472**	0.327***	0.299***	0.217**	0.216**	0.327***
	(0.178)	(0.184)	(0.192)	(0.084)	(0.081)	(0.084)	(0.085)	(0.084)
Log of GDP_j	1.513***	1.900***	1.994***	0.469***	0.474***	0.561***	0.574***	0.469***
	(0.179)	(0.186)	(0.190)	(0.081)	(0.079)	(0.081)	(0.082)	(0.081)

Variables are statistically significant at *0.1, **0.05 and ***0.001 levels.

Table 11: Conditional and unconditional marginal effects for vegetables and fish sectors

Variable	Vegetables				Fish			
	1990	1995	2000	2005	1990	1995	2000	2005
	Conditional							
Log of Distance	-1.165***	-1.170***	-1.128***	-1.162***	-0.926***	-0.914***	-0.903***	-0.910***
	(0.055)	(0.054)	(0.055)	(0.057)	(0.048)	(0.047)	(0.046)	(0.047)
Common Border	0.962***	0.983***	1.116***	1.092***	0.954***	0.954***	0.976***	0.954***
	(0.167)	(0.163)	(0.168)	(0.176)	(0.114)	(0.113)	(0.113)	(0.113)
Preferential Trade Agreement	0.411***	0.471***	0.565***	0.588***	0.289**	0.290**	0.296***	0.319***
	(0.113)	(0.111)	(0.109)	(0.114)	(0.094)	(0.092)	(0.092)	(0.091)
Log of GDP_i	0.680***	0.797***	0.594***	0.544***	0.431***	0.427***	0.417***	0.405***
	(0.133)	(0.135)	(0.141)	(0.137)	(0.119)	(0.117)	(0.120)	(0.119)
Log of GDP_j	0.223*	0.019	0.280**	0.390**	0.271**	0.287**	0.301***	0.283**
	(0.130)	(0.133)	(0.140)	(0.135)	(0.118)	(0.116)	(0.120)	(0.118)
	Unconditional							
Log of Distance	-2.350***	-2.721***	-2.538***	-2.539***	-1.963***	-2.104***	-2.109***	-2.116***
	(0.157)	(0.171)	(0.164)	(0.162)	(0.082)	(0.087)	(0.088)	(0.088)

Common Border	2.752***	2.863***	2.779***	2.902***	1.515***	1.590***	1.614***	1.624***
	(0.520)	(0.514)	(0.505)	(0.470)	(0.326)	(0.339)	(0.338)	(0.336)
Preferential Trade Agreement	1.511***	1.660***	1.987***	2.034***	0.871***	0.937***	1.070***	1.149***
	(0.347)	(0.345)	(0.319)	(0.312)	(0.185)	(0.191)	(0.193)	(0.192)
Log of GDP_i	2.075***	2.651***	2.442***	2.773***	1.650***	2.249***	2.102***	1.997***
	(0.381)	(0.354)	(0.368)	(0.369)	(0.186)	(0.192)	(0.199)	(0.197)
Log of GDP_j	3.155***	2.487***	2.613***	2.260***	0.818***	0.315*	0.486**	0.580**
	(0.378)	(0.349)	(0.368)	(0.363)	(0.180)	(0.186)	(0.193)	(0.192)

Variables are statistically significant at *0.1, **0.05 and ***0.001 levels.

Table 12: Conditional and unconditional marginal effects for fruits and sugar sectors

Variable	Fruits				Sugar			
	1990	1995	2000	2005	1990	1995	2000	2005
	Conditional							
Log of Distance	-0.824***	-0.847***	-0.873***	-0.900***	-1.450***	-1.467***	-1.443***	-1.448***
	(0.045)	(0.045)	(0.046)	(0.046)	(0.078)	(0.077)	(0.077)	(0.077)
Common Border	1.202***	1.192***	1.162***	1.178***	0.698**	0.743***	0.888***	0.976***
	(0.122)	(0.121)	(0.123)	(0.122)	(0.232)	(0.224)	(0.222)	(0.224)
Preferential Trade Agreement	0.526***	0.485***	0.493***	0.443***	0.659***	0.452***	0.542***	0.593***
	(0.092)	(0.093)	(0.092)	(0.092)	(0.141)	(0.140)	(0.137)	(0.139)
Log of GDP_i	0.317**	0.489***	0.374***	0.248**	0.483***	0.471***	0.388**	0.538***
	(0.112)	(0.114)	(0.116)	(0.113)	(0.140)	(0.141)	(0.135)	(0.137)
Log of GDP_j	0.623***	0.344**	0.545***	0.749***	0.644***	0.553***	0.741***	0.616***
	(0.115)	(0.117)	(0.118)	(0.115)	(0.136)	(0.135)	(0.130)	(0.133)
	Unconditional							
Log of Distance	-1.965***	-2.112***	-2.082***	-2.144***	-2.819***	-3.101***	-3.075***	-3.240***
	(0.111)	(0.115)	(0.115)	(0.116)	(0.163)	(0.178)	(0.175)	(0.178)
Common Border	2.442***	2.616***	2.719***	2.646***	1.560**	2.129***	1.970**	1.797**

	(0.386)	(0.381)	(0.364)	(0.369)	(0.619)	(0.630)	(0.644)	(0.684)
Preferential Trade Agreement	1.132***	1.139***	1.275***	1.235***	1.809***	1.886***	2.138***	1.837***
	(0.250)	(0.249)	(0.247)	(0.246)	(0.378)	(0.373)	(0.369)	(0.366)
Log of GDP_i	2.204***	2.665***	2.380***	2.578***	1.305***	1.718***	1.202***	1.701***
	(0.262)	(0.256)	(0.267)	(0.266)	(0.351)	(0.325)	(0.337)	(0.359)
Log of GDP_j	2.293***	1.565***	1.971***	1.933***	3.268***	3.013***	3.535***	2.947***
	(0.255)	(0.250)	(0.262)	(0.261)	(0.363)	(0.330)	(0.353)	(0.362)

Variables are statistically significant at *0.1, **0.05 and ***0.001 levels.

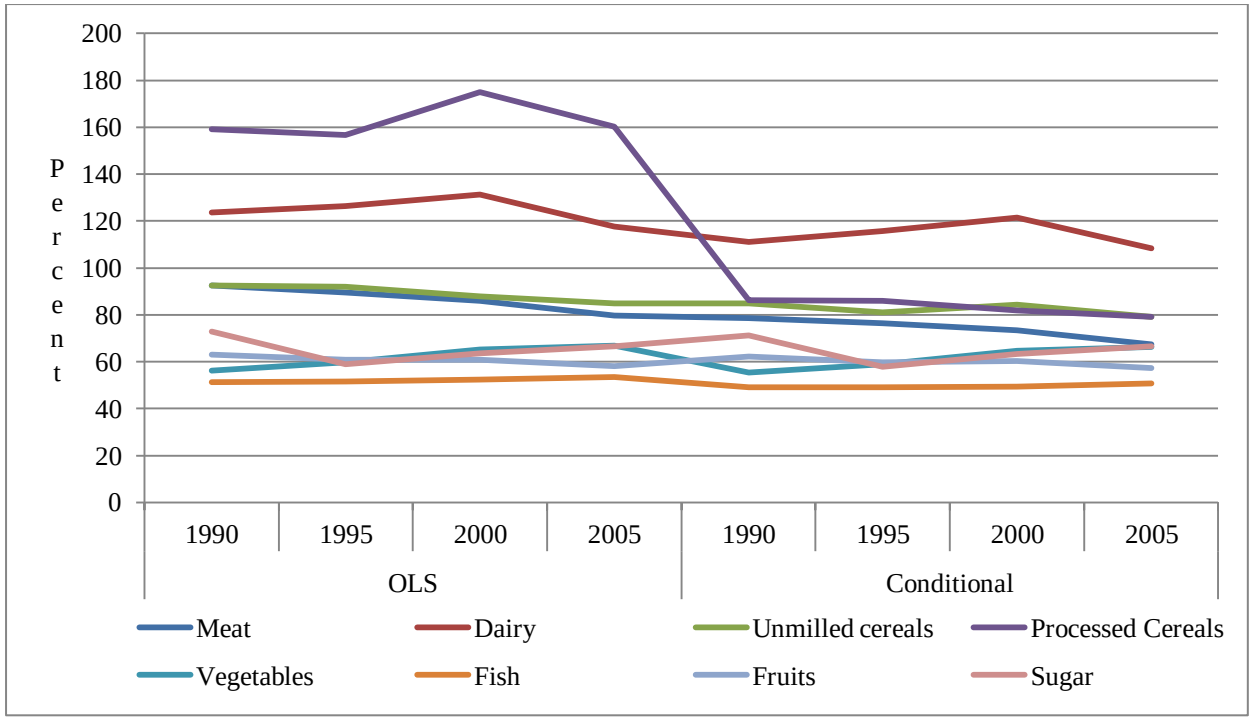

Figure 1: The conditional and OLS estimates of the effect of PTAs on members' agrifood trade

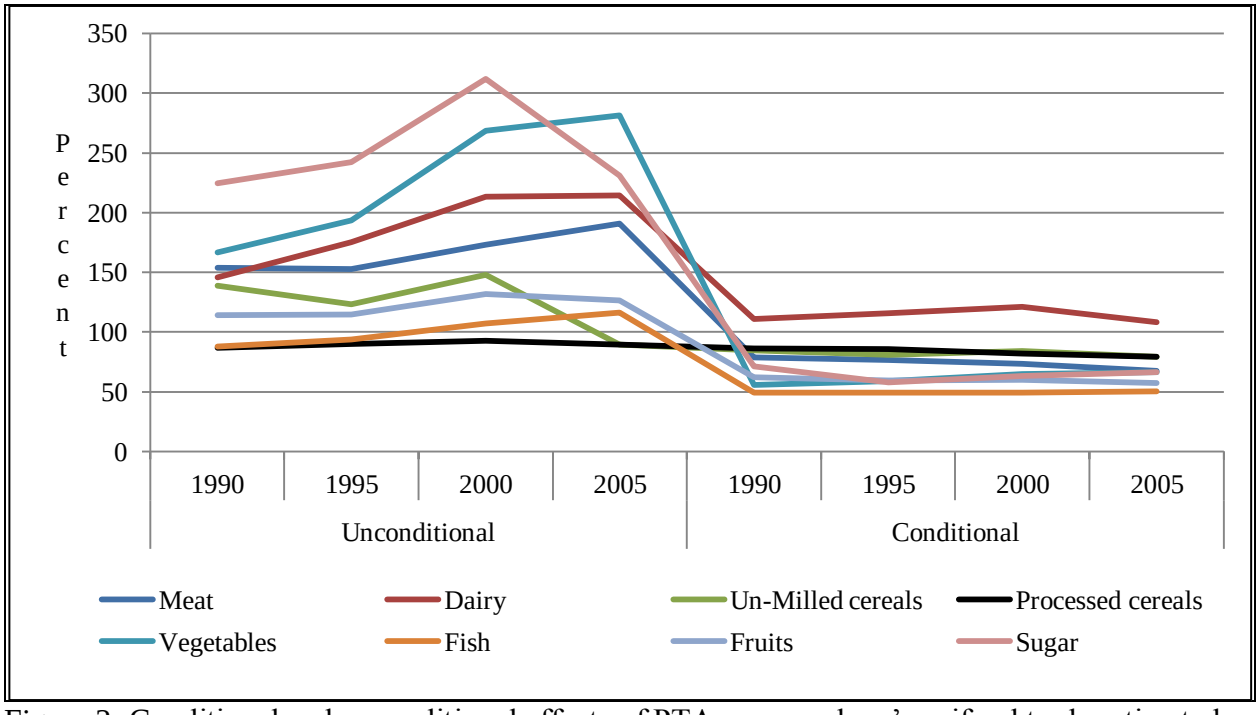

Figure 2: Conditional and unconditional effects of PTAs on members' agrifood trade estimated using Heckman's procedure