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Abstract

This work provides an analysis of the impact on trade of EU preferences in the agricultural sector. We focus on the agricultural sector because it is a crucial resource for many poor economies and because half of EU agricultural imports benefits from a preferential tariff. In fact, over the time a large number of preferential trade arrangements has been concluded between the EU and developing countries in order to integrate them in world trade and to promote their economic growth. From the methodological point of view, with respect to the existing literature using gravity equations in order to assess the impact of non-reciprocal preferential trade policies we use an explicit measure of the intensity of the preference margins at the 6-digit tariff line level. Moreover, our estimation framework takes into account the heterogeneity across exporters and products, as well as the potential selection bias implied by the presence of zero-trade flows. We model the preferences for agricultural products granted by the EU in 2004 performing several regressions in order to compare the impact on different exporting countries and to highlight the contribution of different commodity groups. Even if our results confirm an overall positive impact of preferences on trade, we show that there are significant differences across products and between various exporters.

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1. Introduction

This work provides an analysis of the impact on trade of EU preferences in the agricultural sector. The analysis covers the imports of agricultural products from developing countries to 15 EU members. The choice of this sample is motivated by the fact that the EU has been increasing its use of preferential regimes in order to promote the economic development as well as the integration of developing countries in the world economy. In this respect, it is well-known the agricultural sector plays a crucial role since it accounts for a large share of developing countries' economies and is highly protected in the European market.

In section 2, we briefly review the literature that has analyzed the impact of these policies. From the methodological point of view, the commonly used econometric approach is the gravitational model, based upon Newton's Law of Gravitation, predicting that the volume of trade between two economies increases with their size (proxies are real GDP, population, land area) and decreases with transaction costs measured as bilateral distance, adjacency, cultural similarities (Baldwin, 1994; Eichengreen and Irwin, 1996; Feenstra, 1998; Anderson and van Wincoop, 2003). We follow Anderson (1979) and Anderson and van Wincoop (2003) and construct a theoretically grounded gravity equation, where the trade cost factor as a function of observables bilateral distance, tariff and preferential margin (see Section 3).

In general, preferential policies are introduced as a dummy variable, that assumes the value "1" if the trade is between two countries belonging to a preferential agreement and "0" otherwise. On the contrary, we use an explicit measure of the intensity of the preference margins at the 6-digit tariff line level. The preference margin for each product is calculated on a bilateral basis as the difference between the maximum applied duty by the EU across all exporters and the duty faced by a specific exporter.

Moreover, the assessment of the impact of trade preferences should be carried out using disaggregated data rather than total exports, as any discriminatory trade agreement applies at product level: the use of disaggregated data allows a more accurate analysis of policies that often discriminate among products (Aiello et al., 2006). On the other hand, it also leads to two types of shortcomings: (*i*) the elevated percentage of "zero trade flows"; (*ii*) the impossibility, for some variables, to get information at the level of details at which tariff lines are specified. The presence of zero values create obvious problems in the log-linear form of the gravitational equation.

In order to avoid the bias that would be implied by the drop of the observations with zero flows, we implement the Heckman two-step procedure consistently with the best practices in the literature (Helpman, Melitz and Rubistein, 2007; Linders and de Groot, 2006). As far as the lack of data is concerned, in order to control for the unobservable country and product heterogeneity we introduce product- and country-specific fixed effects. We estimate cross-sectional models for data on imports of 689 agricultural products from 145 DCs to 15 members of the EU provided by the MAcMap-HS6 database for year 2004 (Section 4).

We obtain estimates of the impact of preferences on trade intensity for country group/ policies and for classes of products. Moreover, we also explore the sensitivity of the results to different levels of aggregation for the importing region, i.e. considering the 15 EU countries individually or as an aggregate. In general, the results confirm that preferential regimes produce positive impacts both on the probability of trade and on trade intensity. However the results also describe a picture in which preferential regimes have very different impacts across products and between various exporters result very different among groups of countries. (Section 5).

2. EU Trade Policy and the developing countries: a brief survey of literature

The EU is engaged in a web of preferential trade relations with other countries or regional groupings, which range from the regular Generalized System of Preferences (GSP), to specific provisions for LDCs (i.e. the Everything But Arms – EBA – initiative), the Africa-Caribbean-Pacific agreement (i.e. the Lomé/Cotonou agreements) and the Bilateral Euro-Mediterranean Association Agreements.[1]

The new EU GSP scheme, recently extended till 2008, includes three categories of benefits: the General Scheme for all (112) developing countries; the EBA initiative granting to the LDCs duty-free access on all products with the exception of arms and munitions; the "GSP plus", providing duty-free access to all products from "countries with special development needs" which implement international conventions on the environment, and on human rights and labour standards.

The regular GSP provides for very differentiated margins of preferences with 40 percent of (non-sensitive) products receiving duty-free access, but with ceilings and graduation criteria that eliminate the largest exporters. As far as the remaining (sensitive) products are

[1] For a detailed analysis of these preferential schemes see Bureau et al. (2004) and Gallezot (2005).

concerned, the MFN *ad valorem* duties are reduced by 3.5 percentage points, while specific duties are reduced by 30%.

The EBA considerably improved the extent of the preferential market access granted to LDCs. Since 2002, as a matter of fact, duty-free access is extended without any quantitative restrictions to all products except for arms and three sensitive products, namely bananas, rice and sugar (for these products a transition arrangement is forecasted until 2009). The EBA follows the same rules of origin specified in the GSP. This is seen as a major restriction to exporting processed products under the EBA, especially for small countries that find it difficult to find all components of their products within their boundaries (Bureau et al., 2004).

The Cotonou Partnership Agreement includes preferences and linkages between trade and financial assistance for the over 70 ACP countries, which are mostly former colonies of the EU member States. The agreements constitute the follow-up of the of Yaoundé and Lomé Conventions which provided non-reciprocal trade benefits in 99 percent of industrial goods and some agricultural products. The Lomé preferences will last until 31 December 2007 (except for LDCs), after which reciprocity will be gradually introduced through new Economic Partnership Agreements (EPAs). While the GSP is conceived as a unilateral, unbound grant by industrialized countries, the Lomé/Cotonou preferences are an integral part of a broader international treaty which is legally binding upon the two parties and by which the EU has committed itself on a contractual basis to ensure non-reciprocal preferential market access conditions for ACP products.

The EU also has bilateral arrangements with 10 Mediterranean countries. The Euro-Mediterranean partnership was launched at the 1995 Barcelona Conference, which forecasted a free trade Area by 2010. The Bilateral Euro-Mediterranean Association Agreements are a first step in this direction. Some of these agreements provide for non-reciprocal free access for non-sensitive products into the EU market and progressive liberalization for other products.

The literature on trade preferences focuses on two main issues: (*i*) the value of preferences, and (*ii*) their impact on trade.

Many works measure the value of preferences as the benefit that receiving countries might draw from trade preferences (Alexandraki and Lankes, 2004; Bouët et al., 2005; Candau and Jean, 2005). Under simplifying assumptions (perfect substitutability across origins and constant world prices, in particular), a simple calculation of the value of the rent (V_j) arising from preferential tariff duties for any partner *j* can be carried out:

$$V_j = \sum_i (mfn_i - pref_{ij}) M_{ij} util_{ij}^{pref} \quad [1]$$

where *i* is the tariff line, *mfn* and *pref* are respectively the MFN and the preferential applied tariff duty, *M* refers to a country's dutiable imports of product *i* from partner *j*, and *util* is the corresponding utilisation rate (i.e. the ratio of exports under the EBA to exports eligible to the EBA). Using this measure, Candau and Jean (2005) find that EU tariff preferences are an important stake for a number of developing countries, in particular in sub-Saharan Africa: for all country groups except the GSP-only countries, they represent a significant proportion of the value of dutiable exports to the EU (up to 10% for sub-Saharan African countries and LDCs).

Given the relevance of the *util* parameter in the calculation of *V*, it is not surprising that the utilization rate of preferences has attracted a substantial body of research (Brenton, 2003; Bureau et al, 2004; Manchin, 2004; Mold, 2004; Stevens and Kennan, 2004; Anson e al., 2005; Augier et al., 2005; Estevadeordal and Suominen, 2005; Candau and Jean, 2005). It has been argued that the use of some schemes is limited by stringent rules of origin and administrative complications that make it very difficult for exporters to comply with the scheme's requirements (Gallezot and Bureau, 2004; Stevens and Kennan, 2004; Candau and Jean, 2005). Focusing on each agreement separately emerges that the rate of utilization is quite low: for example, the rate of utilization of EBA does not exceed 18% on average and the rate of utilization of the EU GSP scheme for non-LDCs is also relatively low. On the other hand, DCs' exports are often eligible to several preference schemes, so that it is not possible to fill all of them at the same time (Bureau et al, 2004).

As far as the impact on trade is concerned, most of the literature rely on gravity models, based upon Newton's Law of Gravitation, predicting that the volume of trade, M_{ij}, between two economies increases with their size, $Y_{i(j)}$ (proxies are real GDP, population, land area), decreases with transaction costs measured as bilateral distance, d_{ij}, adjacency and intensifies with preferential trade agreements and other factors, such as a common language or colonial ties (Anderson, 1979; Anderson and van Wincoop, 2003). Typically, the stochastic version of the gravity equation has the form:

$$M_{ij} = \alpha_0 Y_i^{\alpha 1} Y_j^{\alpha 2} d_{ij}^{\alpha 3} \varepsilon_{ij} \quad [2]$$

where ε_{ij} is an error term with $E(\varepsilon_{ij} | Y_i, Y_j, d_{ij}) = 1$, assumed to be statistically independent of the regressors.

Most of the estimates are obtained from cross-country regressions. Even if panel data allow to pin down the estimates of persistent effects with more accuracy, only very recently gravity equations have been estimated using panel data techniques. In this respect, it is worth recalling that the theoretically grounded gravity equation is derived by Anderson and van Wincoop (2003) under the assumption that all bilateral trade costs are symmetric and never vary only works with cross section data.

Most of the empirical analyses use gravitational models with aggregated data both in terms of products and in terms of countries. As far as the product aggregation is concerned, it is well-know that it is inconsistent to use aggregate export flows to analyze the effects of trade preferences applied at product level. Indeed, the few works using disaggregated data confirm that the aggregation produces a significant estimation bias (Aiello et al., 2006).

On the contrary, to the best of our knowledge the only mention of the geographical aggregation issue is provided by Engel (2002) that criticizes the use of elasticities of substitution estimated without considering the number of countries involved. By comparing the results for the EU15 as a whole with those obtained taking into account the differences in the import structure of the 15 EU members we provide for the first time an assessment of this type of bias.

The use of disaggregated data implies the presence of an high percentage of "zero trade flows". These zero observations pose no problem for the estimation of gravity equations in their multiplicative form, but they raise a problem in the log-linear specification of the gravity equation that is usually adopted:

$$\ln (M_{ij}) = \ln(\alpha_0) + \alpha_1 \ln (Y_i) + \alpha_2 \ln (Y_j) + \alpha_3 \ln (d_{ij}) + \varepsilon_{ij}. \qquad [3].$$

In many cases, the solution is simply to drop the pairs with zero trade from the data set and estimate the log-linear form by OLS. Even without mentioning the fact that the omission of zero flows could strongly reduce the sample and then lead to a considerable loss of information, limiting of the analysis to observations where bilateral trade flows are positive is a significant source of bias since the selected sample is not random.[2] Zeros may be the result of rounding errors. If trade is measured in thousands of dollars, it is possible that for pairs of countries for which bilateral trade did not reach a minimum value, the value of trade is registered as zero. If these rounded-down observations were partially compensated by rounded-up ones, the overall effect of these errors would be relatively minor. However, the

[2] For a general discussion of the selection bias problem see Wooldridge (2002, cap. 17).

rounding down is more likely to occur for small or distant countries and, therefore, the probability of rounding down will depend on the value of the covariates, leading to the inconsistency of the estimators. The zeros can also be missing observations which are wrongly recorded as zero. This problem is more likely to occur when small countries are considered and, again, measurement error will depend on the covariates, leading to inconsistency.

When the dependent variable is zero for a substantial part of the sample but positive for the rest of the sample, the econometric theory suggests the use of Tobit models. As is typical in the literature, many gravity works perform Tobit estimates by constructing a new dependent variable $y = \ln(1+M_{ij})$. However, this procedure relies on rather restrictive assumptions that are not likely to hold since the censoring at zero is not a "simple" consequence of the fact that trade cannot be negative. Zero flows, as a matter of fact, do not reflect unobservable trade values but they are the result of economic decision making based on the potential profitability of engaging in bilateral trade at all.

Some authors suggest the Poisson Quasi Maximum Likelihood (PQML) estimator as a way to deal with the question of 'zeros' in the trade matrix in order to get unbiased and consistent estimates. Santos Silva and Tenreyro (2005) strongly recommend that gravity type models in particular as well as other constant-elasticity models in general should be estimated in the multiplicative form and suggest a simple quasi-maximum likelihood estimation technique based on Poisson regression (Siliverstovs and Schumacher, 2006).

Even if the PQML procedure offers a viable alternative to the traditional OLS in order to handle observed zero trade flows, several recent works implement the Heckman (1979) two stage solution (Linders and de Groot, 2006; Helpman et al., 2007). This procedure, taking into account the information provided by zero-valued observations to get unbiased estimates, is the one we are going to use in this work (see Section 4).

It is not an easy task to summarize the results of the large literature assessing the impact of preferences on trade. The studies report very different estimates, due to the fact that they differ greatly in data sets, sample sizes, independent variables used in the analysis and estimation methods. Anyway, the expectation of the positive impact of preferences on trade is by far and large confirmed.

Regarding the estimated coefficients of the impact of preferences, comprehensive surveys of the estimated PTAs impact are provided by Nielsen (2003) and Cardamone (2007). Many

works focus specifically on the EU policies (Nilsson, 2002; Adam et al., 2003; Persson and Wilhelmsson, 2005; Verdeja, 2006).

The EU GSP scheme does not seem to have a large impact, since the imports coefficient ranges from 0.04 to 0.86 (Nilsson, 2002; Rose, 2004a; Persson and Wilhelmsson, 2005; Verdeja, 2006), and some authors even find highly significant negative coefficients (Oguledo and Macphee, 1994; Nilsson, 2002; Rose, 2004b; Subramanian and Wei, 2005). Looking at the results for different sectors, Subramanian and Wei (2005) report positive estimates only for the clothing industry, while it is negative for the footwear and food industries.

Several studies (Carrère, 2004; Nilsson, 2005; Persson and Wilhelmsson, 2005; Aiello et al., 2006) find that the EBA initiative provided a significant to LDCs' exports. Positive results have also been obtained for ACP countries, (Carrère, 2004,Nilsson, 2005; Acosta-Rojas et al., 2005; Persson and Wilhelmsson, 2005; Persson, 2007, Verdeja (2006), as well as in ther case of the Euro-Mediterranean agreements (Gaulier et al., 2004; _lvarez-Coque and Martì-Selva, 2006; Pusterla, 2007), though the estimated impact is in some cases is exceedingly high (Amurgo-Pacheco, 2006, estimates elasticity coefficients ranging between 3.09 and 5.2).

3. Gravity model

We follow Anderson (1979) and Anderson and van Wincoop (2003) in order construct our gravity equation including many commodity classes of goods (denoted by k where $k=1,2....K$) flowing between each country i and j. A trade separable model, in which the allocation of the value of production and expenditure in country j for product class k is separable from the bilateral allocation of trade across countries, allows the two stage budgeting needed to separate the allocation of expenditure across product classes from the allocation of expenditure within a product class across countries of origin (Armington assumption). In simple words, consumption decisions are taken at two different levels: in the first stage the decision is how much to consume across product classes; in the second stage the decision is how much to import within a product class across countries of origin, so that bilateral trade is determined in "conditional general equilibrium" whereby product markets for each good produced in each country clear conditional on the observed output structure, Y_{jk}, and expenditure allocations, E_{jk}.

The CES subutility function for product k, for importer j, facing $i = 1…I$ exporting sources can be written as follows:

$$u_{jk} = \left[\sum_i \beta_{ik}^{-\theta_k} c_{ijk}^{\theta_k}\right]^{1/\theta_k} \quad [4]$$

where c_{ijk} is the country j consumption for the commodity k importer from country i, β_{ik} is a demand shifter, which could represent unobserved differences in the number of distinct varieties available from each exporter positive parameter and $\theta_k = (\sigma_k - 1)/\sigma_k$, with $\sigma_k > 1$ representing the elasticity of substitution among all varieties from different exporters. Consumers maximize their utility [4] subject to:

$$\sum_i p_{ijk} c_{ijk} = E_{jk} \quad [5]$$

where E_{jk} is the country j's expenditure for product class k.

Define the price index for commodity k in each country, P_{jk}, over the prices of individual varieties produced in i and sold in j, p_{ijk},

$$P_{jk} = \left[\sum_i (\beta_{ik} p_{ijk})^{1-\sigma_k}\right]^{1/1-\sigma_k} \quad [6]$$

The imported good's expenditure share is linked to its relative price by:

$$\varphi_{ijk} = \left(\frac{\beta_{ik} p_{ijk}}{P_{jk}}\right)^{1-\sigma_k} \quad [7],$$

while the nominal demand for commodity k of country i by country j is:

$$m_{ijk} = p_{ijk} c_{ijk} = \varphi_{ijk} E_j = \left(\frac{\beta_{ik} p_{ijk}}{P_{jk}}\right)^{1-\sigma_k} E_j \quad [8].$$

Finally, using the national account identity between total expenditure (E_j) and total income (Y_j) we get:

$$m_{ijk} = \left(\frac{\beta_{ik} p_{ijk}}{P_{jk}}\right)^{1-\sigma_k} Y_j \quad [9].$$

Prices differ between locations due to trade costs. Letting p_{ik} denote the exporter's supply price for commodity k, net of trade costs, and t_{ikj} be the *trade cost factor* between i and j for commodity k , such that $p_{ijk}=p_{ik}t_{ijk}$, we get:

$$m_{ijk} = \left(\frac{\beta_{ik} p_{ik} t_{ijk}}{P_{jk}}\right)^{1-\sigma_k} Y_j \quad [10].$$

Moreover, assuming that the production of commodity k for country i is a fraction of total output, the market-clearing condition implies:

$$\varphi_{ik} Y_i = \sum_j m_{ijk} = (\beta_{ik} p_{ik})^{1-\sigma_k} \sum_j \left(\frac{t_{ijk}}{P_{jk}} \right)^{1-\sigma_k} Y_j \qquad [11].$$

Using the [11] to get the equilibrium scaled prices $\{\beta_{ik} p_{ik}\}$ and substituting them in the demand equation [10], we get:

$$m_{ijk} = \frac{\left(t_{ijk} / P_{jk}\right)^{1-\sigma_k} \varphi_{ik} Y_i Y_j}{\sum_j \left(t_{ijk} / P_{ijk}\right)^{1-\sigma_k} Y_j} \qquad [12]$$

Define world national income by $Y_w = \sum_j Y_j$, income shares by $\theta_j = Y_j / Y_w$, and, assuming that the trade barriers are symmetric (that is: $t_{ijk} = t_{jik}$), the exporter's price index for good *k* by $P_{ik} \equiv (\sum_j t_{ijk} / P_{jk})^{1-\sigma_k} \theta_j)^{1/1-\sigma_k}$, to get the gravity equation:

$$m_{ijk} = \frac{\varphi_{ik} Y_i Y_j}{Y_w} \left(\frac{t_{ijk}}{P_{ik} P_{jk}} \right)^{1-\sigma_k} \qquad [13].$$

Trade costs (depend on transport costs, proxied by distance d_{ij}), tariffs (τ_{ijk}) imposed by country *j* on imports of commodity *k* from country *i*, and preferential margins $pref_{ijk}$:

$$t_{ijk} = \tau_{ijk} d_{ij} (pref_{ijk})^{-1} \qquad [14].$$

Finally, we can rewrite the gravity equation in [13] as:

$$m_{ijk} = \frac{\varphi_{ik} Y_i Y_j}{Y_w} \left(\frac{\tau_{ijk} d_{ij}}{P_{ik} P_{jk} pref_{ijk}} \right)^{1-\sigma_k} \qquad [15],$$

or in the logarithmic form:

$$\ln m_{ijk} = k + \ln Y_i + \ln Y_j + \ln \varphi_{ik} + (1-\sigma_k) \ln \tau_{ijk} + (1-\sigma_k) \ln d_{ij} - (1-\sigma_k) \ln pref_{ijk} - (1-\sigma_k) \ln P_{ik} - (1-\sigma_k) \ln P_{jk} + \varepsilon \qquad [16].$$

4. Econometric estimation

In order to estimate Eq. [16], we firstly have to overcome some problematic issues on data regarding multilateral price terms and unobserved shares, φ_{ik}, and elasticity of substitution, σ_k. In literature three methods are suggested to account for price effects in the gravity equation: (1) the use of published data on price indexes (Bergstrand, 1985, 1989; Baier and Bergstrand, 2001; Head and Mayer, 2000); (2) direct estimation *à la* Anderson and van Wincoop (2003);

(3) or the use of country fixed effects (Hummels, 1999; Rose and van Wincoop, 2001; Eaton and Kortum, 2002; Feenstra, 2002; Redding and Venables, 2000).

The main weakness of the first method is that the existing price indexes may not accurately reflect the true border effects (Feenstra, 2002). Accordingly, Anderson and van Wincoop (2003) estimate the structural equation with nonlinear least squares after solving for the multilateral resistance indices as a function of the observables bilateral distances and a dummy variable for international border. However, the computationally easier method for accounting for multilateral price terms in cross section – that will also generate unbiased coefficient estimates – is to estimate the gravity equation using country-specific fixed effects. Moreover, since detailed data on consumption shares are not available, the only way to take account of the unobserved shares, φ_{ik}, is to include commodity k fixed effects. Let Φ^k denote a dummy equal to "1" if imported good is commodity k, and "0" otherwise; let Φ_1^i denote a dummy equal to "1" if country i is the exporter, and "0" otherwise; and let Φ_2^j denote a dummy equal to "1" if country j is the importer, and "0" otherwise. Equation [16] becomes:

$$\ln m_{ijk} = k + \ln Y_i + \ln Y_j + \beta^k \Phi^k + (1-\sigma_k)\ln \tau_{ijk} + (1-\sigma_k)\ln d_{ij} + (\sigma_k - 1)\ln pref_{jk} + \beta_1^i \Phi_1^i + \beta_2^j \Phi_2^j + \varepsilon \qquad [17],$$

where the coefficients $\beta^k = \ln \varphi_{ik}$, $\beta_1^i = \ln(P_{ik})^{\sigma_k - 1}$ and $\beta_2^j = \ln(P_{jk})^{\sigma_k - 1}$.

Estimates of coefficients are very sensitive to assumptions about the elasticity of substitution σ_k. Some authors (Feenstra, 1994; Eaton and Kortum, 2002) use data on prices to estimate σ_k through the demand equation. Other authors estimate this elasticity through the gravity equations using information about directly observed trade barriers, such as tariffs and/or transport costs (Hummels, 2001; Baier and Bergstrand, 2001; Head and Ries, 2001).

We do not estimate the elasticity of substitution, but we explore the sensitivity of the using different values for σ_k. In order to choose the values, we follow Anderson and van Wincoop (2004) that offer a review of methodologies used to estimate the elasticity of substitution and conclude that the overall estimated σ_k is likely to be in the range of 5 to 10. Since more disaggregated data might lead to find a higher estimate of the elasticity of substitution, we use the following values for σ_k: 8, 10 and 20.

As it was mentioned in Section 2, the existence of observations for which the dependent variable is zero creates problems since these zero flows do not reflect unobservable trade values rather they are the result of economic decisions about the potential profitability of

engaging in trade at all. In order to address this issue we adopt the Heckman (1979) sample selection model.

The Heckman two-step approach transforms a selection bias problem into an omitted variable issue solved by including an additional variable, the *Mills ratio*, between the regressors. However, Helpman et al. (2007) recently pointed out that used alone, the standard Heckman correction would only be valid in a world without firm-level heterogeneity, or where such heterogeneity is not correlated with the export decision: "Then, all firms are identically affected by trade barriers and country characteristics, and make the same export decisions – or make export decisions that are uncorrelated with trade barriers and country characteristics" (p. 13). Accordingly, they propose a variant to the two stage estimation procedure that simultaneously corrects for both types of potential bias, adding in the gravity equation à la Anderson and van Wincoop a new variable ω_{ij}, that controls for the fraction of firms that export from j to i.[3]

The first stage consists of estimating a Probit equation that specifies the probability that country i exports to j as a function of observable variables:

$$\rho_{ij} = \Pr(M_{ij}^* > 0 \mid \text{observed variables}) = \Phi(\gamma' W_{ij}^* + \xi_j^* + \varsigma_i^*) \qquad [18]$$

where ξ and ζ are exporter and importer fixed effects, respectively. $\Phi(.)$ is the cumulative distribution function of the unit-normal distribution, and every starred coefficient represents the original coefficient divided by the standard deviation σ_η. Predicted components of this equation are used to construct the inverse Mills ratio and the additional control that corrects for the biases generated by the underlying unobserved firm-level heterogeneity.

Letting $\hat{\rho}_{ij}$ be the estimated probability of exports from j to i, using the estimates from the probit equation and let $\hat{\gamma}_{ij}^* = \varphi^{-1}(\hat{\rho}_{ij})$ be the estimated latent variable $\gamma_{ij}^* \equiv \gamma_{ij}/\sigma_\eta$, we construct the inverse Mills ratio $\hat{\lambda} = \dfrac{\varphi(\hat{\gamma}_{ij}^*)}{\Phi(\hat{\gamma}_{ij}^*)}$ and $\hat{\omega} = \ln\left\{\exp\left[\delta\left(\hat{\gamma}_{ij}^* + \hat{\lambda}\right) - 1\right]\right\}$. Then in the second stage we estimate β by least squares regression of M_{ij} on explanatory variables X_{ij}, $\hat{\lambda}$ and $\hat{\omega}$:

$$M_{ij} = \beta' X_{ij} + \ln\left\{\exp\left[\delta\left(\hat{\gamma}_{ij}^* + \hat{\lambda}\right) - 1\right]\right\} + \hat{\lambda} + \varepsilon_{ij} \qquad [19]$$

[3] When ω_{ij} is not included on the right-hand-side, the coefficient of elasticity of any potential trade barriers can no longer be interpreted as the elasticity of a firm's trade with respect to the trade barrier. The estimation of the standard gravity equation confounds the effects of trade barriers on firm-level trade with their effects on the proportion of exporting firms, which induces an upward bias in the estimated elasticity of the trade barrier.

observed only if $M_{ij} = 1$. The term $\hat{\lambda}$ is the standard Heckman (1979) correction for sample selection and the additional control $\hat{\omega}$ corrects for the unobserved firm-level heterogeneity. The two stage approach does not only correct for possible biases, but it also allows to distinguish the impact of preferences on the extensive and on the intensive margin. An increased probability of registering a positive trade flow, as a matter of fact, signals the existence of a larger set of traded goods (*extensive margin*), while the coefficient associated with the preference margin in the second stage refers to the trade of larger quantities than would have been the case without the preference (*intensive margin*).

We estimate a cross-sectional model, covering imports in 689 agricultural commodities (WTO definition at 6-digit Harmonized System) from 145 developing countries to 15 EU members in 2004. In order to get correct standard errors, we adopt a "robust with cluster" procedure, adjusting standard errors for country-pair correlation, where each cluster identifies imports from the same exporter.

Data on trade at HS6 level of detail is provided by the MAcMap-HS6 database (www.cepii.fr) based on UN Commodity Trade Statistics data (Comtrade). Trade values are calculated f.o.b. in order to avoid consistency problems, since c.i.f. values would be correlated with the error term. MAcMap also provides a consistent assessment of protection across the world, including *ad valorem* equivalent rates of applied tariff duties and tariff rate quotas at the six-digit level of the Harmonized System. However, the tariff level τ is finally excluded from the set of control variables in order to avoid multicollinearity problems with the preference margins.

The product-specific preferential margin for each exporter is calculated as the difference between the highest tariff applied by EU and the duty paid by that exporter. The final dataset excludes trade in tariff lines with zero MFN rates, since trade that takes place in these lines cannot be considered preferential (Medvedev, 2006). Data for the remaining explanatory variables are based on a dataset provided by the Cepii that includes the set of different distance variables and a set of variables commonly used in gravity equations, such as colonial links, common languages, contiguity.

From the geographical point of view we distinguish four groups (in brackets the number of countries)[4] corresponding to the most important EU preferential schemes (see Section 2): ACP (72), LDCs (48), GSP-only (77), Mediterranean (8). Regarding the product detail, we

[4] The sum of the numbers exceeds to total number of DCs (145) due to multiple memberships.

define 4 groups, according to the HS-2 Code Commodity Classification (in brackets the number of HS6 tariff lines): animal products (HS Chapters 01-05: 114 tariff lines); vegetable products (HS chapters 06-14: 271 tariff lines); edible oils (HS Chapter 15: 46 tariff lines); food and beverages (HS Chapter 16-24: 177 tariff lines).[5]

Since zero trade values raise several econometric problems, it is worth mentioning that the percentage of positive bilateral trade flows is only 15% when we consider the imports for each of the 15 EU members. At the aggregate level such a percentage is obviously higher (it is sufficient that a product is imported in at least one EU country) reaching 72%. In the same vein it is worth emphasizing that working at the aggregate EU level drastically reduces the number of observations from 347,535 to 23,175.

Overall, more than half of the EU agricultural imports may benefit from trade preferences (Table 1). A significant share of these imports (17%) is duty-free, though this percentage varies a lot, ranging from 12% in the case of the GSP to 44% in the case of the LDCs. It is worth emphasizing, though, that these figures should be considered an upper limit since we cannot be sure that each and every trade flow is able to comply with the regulations (such as the rules of origin) associated with the preference.

Considering the trade flows associated with each tariff line, Figure 1 shows that more than 50% of agricultural imports from DCs do not pay any duties. Such a percentage ranges between 97% (LDCs) and 45% (GSP), and roughly half of the duty-free tariff lines can be attributed to the preferential treatment. Considering the products facing a positive applied duty, the largest amount of imports benefits, at least in principle, from a positive preference margin.

Considering only the sample with positive MFN, Figure 2 shows the share of observations with positive preferences and the maximum margin of preference for each group of products. The emerging pattern is quite consistent, since all the sectors present a percentage of preferences exceeding 90%. On the other hand, some differences emerge when we look at the intensity of preferences: the share of tariff lines enjoying a (preferential) duty free access ranges from 25% in the case of animal products to over 50% in the case of vegetable products.

[5] The number of tariff lines does not add up to 689 since we drop those with zero MFN tariffs and the "organic chemicals" group (including products such as essential oils, perfumes and cosmetics) that never presents significant results in our regressions.

Looking at the intensities of the preferential margins, it appears that most of them are very small. This is not surprising, since these margins cannot exceed the MFN duties and the EU rates distribution is very skewed to the left (Figure 3). As a matter of fact, the correlation between preferences and maximum applied duties is quite high for all country groups and ranges between 0.73 (Euro-Mediterranean countries) and 0.93 (LDCs).

Table 2 presents some descriptive statistics for country groups. Looking at the preference margins, LDCs benefit from the largest preferences, followed by ACP, Euro Mediterranean and GSP countries; in terms of products, the largest margins are registered by animal products, followed by prepared foodstuffs, vegetables and edible oils. However, the intensity of EU agricultural trade flows is not related to the value of the preference margins. LDCs, Euro-Mediterranean and ACP countries exports much less than GSP countries.

Table 3 presents some descriptive statistics for commodity groups. Notwithstanding the large average preference margin (39%), the animal products still face the highest bilateral tariffs. The most relevant sectors in terms of trade intensity regard vegetable and food products: the latter benefit of a significant preference margin (22% on average) and this may counterbalance the alleged tariff escalation of the EU trade policy.

Table 4 presents a few indexes that provide a rough picture of EU agricultural imports from DCs. The "intensive margin" percentages give an idea about the relevance of trade flows since they are the shares of each country group on total EU agricultural imports. As it could have been expected, the largest groups (GSP and ACP) are the largest exporters, but the GSP countries register a much larger share (46%) than the ACP (13%). Much lower is the relevance of Euromed agricultural exports to the EU market (7%) and almost negligible the share of the LDCs (2%).

The extensive margin is calculated as the share of positive trade flows over the total number of possible bilateral imports registered by the EU. Such an index should be complemented by the relative export variety index. The is computed as the number of products imported with respect to the total number of possible imports (689 tariff-lines). The two percentages would coincide if each country within a group presented the same export variety. As a matter of fact, the extensive margin is much lower than the export variety and this implies large difference in the composition of exports coming from different countries, and some groups, such as the LDCs or the Euromed countries, on average are able to export less than 10% of all possible products.

5. Econometric Results

We estimate Eq. [17] adopting the Heckman two-step procedure, controlling also for firm-level heterogeneity. We generate two sets of gravity estimates: one using imports to each of the 15 European members, the other considering total imports to the EU15.

Tables from 5 to 9 report estimates of the trade impact of preferential margin by country groups and commodity groups, both for disaggregated 15 European members and for the EU15 as a single importer.[6] In each table, the first row reports the standard gravity "benchmark" equation, the second row reports the estimated probability of positive trade with a preference, while the third block reports the results of the second stage estimation highlighting the row referring to the estimates regarding the impact of preferential margins. In all regressions we find an R-squared between 30% and 60%, and the F-test for the hypothesis that all the slope coefficients (i.e. other than the intercept) are equal to zero is rejected at any standard significance level (prob. F-statistic = 0.00).

Table 5, presents the results for the overall regression, confirms that preferential access leads to a significant expansion of trade between EU and developing countries both in terms of the extensive as well as of the intensive margins. The probit coefficient, as matter of fact, implies that the preferential schemes increased the probability of registering positive trade flows by almost 20%; while the impact on trade intensity is around 2.5. As far as the latter estimate is concerned, it is worth recalling that according to Equation (17) it refers to the composite term $(\sigma_k - 1)\ln pref_{ijk}$. Consequently, in order to interpret it as a trade elasticity with respect to the preference margin we need to make an assumption about the elasticity of substitution, σ. For instance, for elasticity of substitution equal to 8, 10 and 20, we would obtain trade elasticities of 0.35, 0.27 and 0.13, respectively. Accordingly, an increase of the EU preference margins by 10 per cent estimates may lead to an increase of EU agricultural imports from the developing countries between 1.3 and 3.5 per cent according to the degree of imports substitutability. These overall results, though, conceal large differences across groups of exporters and across products.

Table 6 presents the results according to the different preferential schemes using import data for each of the 15 EU member countries. Both controls for selection and heterogeneity

[6] In the case of the overall regression only the results for the EU15 as a single importer are presented due to computing problems in handling quite a large number (347535) of observations.

bias are positive and significant. This implies that the OLS results, though significant, are likely to be severely biased and mostly overstated. The probit regressions confirms the impact of preferences on the existence of positive trade flows: the coefficient is always highly significant and shows that the impact of 1 percent increase in the preference margin on the the probability of trading ranges between 0.04 and 0.18 percentage points. These results are particularly significant in the case of LDCs and Euromed countries, since the countries of these groups are only able to export a small set of products (see Table 4).

Looking at the impact on the trade intensity, the largest impact of preferences on LDCs exports to the EU is not out of the range of other estimates obtained in the literature (Haveman and Schatz, 2003; Nilsson, 2005; Aiello et al., 2006). Assuming an elasticity of substitution of 10, the estimated coefficient (2.84) would implies a trade elasticity of 0.32. The high (and highly significant) coefficient associated with the preference margins shows that the tiny trade flows coming from these countries are highly dependent on preferential access.

The same is true for the ACP and Mediterranean countries, though with a much lower estimated coefficient (0.93). Also in this case our results are within the boundaries of the estimates provided in the literature (Verdeja, 2006; Gaulier et al., 2004; Ålvarez-Coque and Martì-Selva, 2006; Amurgo-Pacheco, 2006; Pusterla, 2007): an increase of the preference margin by 10 per cent would increase exports to the EU by 9.3 per cent in the case of the ACP countries and by 8.3 per cent in the case of the Mediterranean countries even if this estimate is significant only at 10% level.

On the other hand, the GSP scheme is rather effective in terms of impact on the extensive margin, but the impact on the trade flows intensity is not significant. This means that the GSP scheme has succeeded in increasing the set of goods exported to the EU, but it has not managed to affect the volume of trade.

From the methodological point of view, Table 7 confirms the overestimation consequences of the geographical aggregation bias. Moreover, firms heterogeneity does not seem to be a problem when the estimate is carried out at the aggregate level.

Tables 8 and 9 report the results for different commodity groups considering the EU15 members separately and as an aggregate, respectively. Table 8 shows a small but significant impact on the extensive margin for all sectors, with changes in probabilities ranging from 0.03 in the case of edible oils to 0.06 for vegetable products. Looking at the impact in terms of

trade intensity, not surprisingly we find a significant impact for the sectors characterized by the highest preference margins (see Table 3), namely food and animal products. This is consistent with the fact that when the preference margin is small, an exporter may choose to forego the preferences and bring the goods in under MFN rates: accordingly, the lack of significant results for vegetable products and edible oils suggest that for these products the costs of satisfying rules of origin requirements are likely to exceed the value of preferences.

From the methodological point of view, it appears that the standard OLS estimates are likely to lead to an overestimation of the impact on trade. Moreover, in the animal sector there is no evidence of a selection bias, while it is confirmed the necessity to control for firms heterogeneity.

Comparing the results in Tables 8 and 9, it clearly appears that the estimated coefficients are likely to be overstated independently from the chosen estimation method, and we are less likely to find evidence of selection or firms heterogeneity bias. These results suggest the existence of a "geographical aggregation bias" that can lead to a serious overestimation of the preference impact.

6. Conclusions

Over the time a large number of preferential trade arrangements has been concluded between the EU and developing countries in order to integrate them in world trade and to promote their economic growth. We focus on the agricultural sector because it is a crucial sector for many poor economies and most of the EU agricultural imports benefit from preferential tariffs. The purpose of this work is to assess the impact of the preferential margins on trade flows using a gravity equation approach in order to single out the contribution of the preferential policy to the deviation from the "normal" trade levels.

We depart from the existing literature under two main respects. First, we work on highly disaggregated trade data quantifying the intensity of the preference margin, rather than relying on a simple dummy. In order to put the emphasis on the advantages granted with respect to other competitors, preferential margins are computed for each product as the difference between the highest tariff applied by EU and the actual duty paid by each exporter. In this way we give more emphasis not on the amount of duty, but on the fact that the applied tariff for an exporter is the lowest of all exporters. Secondly, we compare the results obtained

working at different level of geographic aggregation, showing how the choice of the importer can also bias the final results.

The econometric results show that preferential policies significantly increase the probability of exports to the EU markets. The largest increases in trade intensity are for the LDCs (2.84), followed by ACP (0.93) and Mediterranean countries (0.83). In terms of sectoral impact, the largest impact of preferences is registered for food and beverages (0.86), while there does not seem to be any impact for the vegetable products: these results are somewhat surprising when compared with the descriptive statistics, and do not confirm the allegation about a possible tariff escalation introduced through the preferential schemes. Overall, though some results may be considered "too good to be true", our estimates are not out of the range of existing results in the literature.

From the methodological point of view, the choice of working at the most detailed level, both in terms of products and in terms of importers, makes the problem of the zero trade flows particularly serious. We deal with this problem through the Heckman correction approach, controlling both for the selection and the firms heterogeneity bias. In this respect, our results do confirm that the traditional OLS tend to largely overstate the true impacts. Finally, we also show that the geographical does matter, and working at an aggregate level tend to inflate the results and hide the evidence about the existence of other possible source of bias.

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TABLES

Table 1: Percentage of preferential imports.

	All DCs	ACP	LDC	GSP	MED
% of preferential imports	54%	61%	51%	53%	70%
% of duty-free preferential imports	17%	34%	44%	12%	41%

Table 2: Descriptive statistics for country groups (ad valorem percentage, Ml $).

		Data for 15 EU members	
		Simple Mean	Total Imports
All DCs – number of observations:	Trade (by country)	0.08	
EU15: 23175	Bilateral applied tariff	19	27,300
15 EU members: 347535	Preference margin	20	
ACP – number of observations:	Trade (by country)	0.06	
EU15: 6765	Bilateral applied tariff	11	6,020
15 EU members: 101475	Preference margin	24	
LDCs – number of observations:	Trade (by country)	0.02	
EU15: 3182	Bilateral applied tariff	4	784
15 EU members: 47730	Preference margin	31	
GSP – number of observations:	Trade (by country)	0.09	
EU15: 15338	Bilateral applied tariff	22	21,100
15 EU members: 230070	Preference margin	17	
Euro-Med – number of observations:	Trade (by country)	0.09	
EU15: 2414	Bilateral applied tariff	21	3,310
15 EU members: 36210	Preference margin	18	

Notes: The sum of the average applied tariff and preference margin varies according to the composition of the export flows.

Table 3: Descriptive Statistics for commodity groups (Ml $).

		Data for 15 EU members	
		Simple Mean	Total Imports
Animal products – number of observations:	Trade (by tariff line)	0.06	
EU15: 2788	Bilateral applied tariff	51	2,520
15 EU members: 41820	Preference margin	39	
Vegetal products – number of observations:	Trade (by tariff line)	0.08	
EU15: 9500	Bilateral applied tariff	13	11,100
15 EU members: 142485	Preference margin	16	
Edible oils – number of observations:	Trade (by tariff line)	0.14	
EU15: 1377	Bilateral applied tariff	11	2,910
15 EU members: 20655	Preference margin	10	
Prepared foodstuffs – number of observations:	Trade (by tariff line)	0.08	
N. of Obs (EU15): 8343	Bilateral applied tariff	18	10,000
N. of Obs (15 EU members): 124545	Preference margin	22	

Table 4: Trade Margins and Relative Export Variety

		Intensive Margin	Extensive Margin	Export Variety
Country Groups	***N. of countries***			
ACP	72	13%	20%	70%
LDCs	48	2%	9%	60%
GSP	77	46%	45%	72%
Euro-Med	8	7%	7%	63%

Table 5: Overall results – Total EU imports

Dependent Variable	*Model*	*Estimated Coefficient*	*Aggregated data for EU15*
Log (M_{ij})	**Benchmark gravity, OLS**	*Preference margin*	1.57*** (0.19)
Pr ($M_{ij} > 0$)	**Probit regression, marginal effects**	*Preference margin*	0.19*** (0.03)
Log (M_{ij})	**Heckman Selection**	*Preference margin*	2.42*** (0.20)
		Inverse Mills ratio(λ)	3.55*** (0.29)
		Firms heterogeneity	-

Notes: (*) significant at 10% level; (**) significant at 5% level; (***) significant at 1% level. Robust Standard Errors in parenthesis.

Table 6: Results by country group – 15 EU members imports

Dependent Variable	*Model*	*Estimated Coefficient*	*Country Group/Policies*			
			ACPs	LDCs	GSP	Mediterranean Countries
Log (M_{ij})	**Benchmark gravity, OLS**	*Preference margin*	1.05 *** (0.29)	1.91 * (1.01)	0.20 (0.16)	1.31 *** (0.41)
Pr ($M_{ij} > 0$)	**Probit regression, marginal effects**	*Preference margin*	0.04 *** (0.01)	0.04 *** (0.02)	0.18 *** (0.04)	0.15 *** (0.02)
Log (M_{ij})	**Heckman Selection**	*Preference margin*	0.93 *** (0.29)	2.84 *** (1.00)	0.19 (0.24)	0.83 * (0.44)
		Inverse Mills ratio(λ)	1.98 *** (0.21)	3.83 *** (0.59)	2.10 *** (0.32)	1.73 *** (0.30)
		Firms heterogeneity	3.21 *** (0.30)	2.51 *** (0.56)	2.58 *** (0.41)	2.52 *** (0.38)

Notes: (*) significant at 10% level; (**) significant at 5% level; (***) significant at 1% level. Robust with Cluster (for country pair) Standard Errors in parenthesis.

Table 7: Results by country group – Total EU imports

Dependent Variable	*Model*	*Estimated Coefficient*	*Country Group/Policies*			
			ACPs	LDCs	GSP	Mediterranean Countries
Log (M_{ij})	**Benchmark gravity, OLS**	*Preference margin*	1.58 *** (0.47)	2.38 * (1.28)	1.34 *** (0.29)	1.90 ** (0.77)
Pr ($M_{ij} > 0$)	**Probit regression, marginal effects**	*Preference margin*	0.23 *** (0.06)	0.34 * (0.19)	0.16 *** (0.04)	0.45 *** (0.12)
Log (M_{ij})	**Heckman Selection**	*Preference margin*	1.93 *** (0.53)	-	1.97 *** (0.30)	3.80 * (0.86)
		Inverse Mills ratio(λ)	1.43 *** (0.62)	-	2.87 *** (0.31)	2.01 *** (0.70)
		Firms heterogeneity	-	-	-	-

Notes: (*) significant at 10% level; (**) significant at 5% level; (***) significant at 1% level. Robust Standard Errors in parenthesis.

Table 8: Results by commodity group – 15 EU members imports

Dependent Variable	*Model*	*Estimated Coefficient*	*Commodity Groups*			
			Animal Products	Vegetable Products	Edible Oils	Prepared foodstuffs
Log (M_{ij})	**Benchmark gravity, OLS**	*Preference margin*	1.53 *** (0.32)	0.44 ** (0.21)	-0.36 (0.61)	0.88*** (0.20)
Pr ($M_{ij} > 0$)	**Probit regression, marginal effects**	*Preference margin*	0.05 *** (0.01)	0.06 *** (0.01)	0.03** (0.02)	0.05*** (0.01)
Log (M_{ij})	**Heckman Selection**	*Preference margin*	0.58 * (0.34)	0.31 (0.23)	-0.43 (0.66)	0.86*** (0.20)
		Inverse Mills ratio(λ)	-	2.22 *** (0.22)	3.12*** (0.72)	2.54*** (0.25)
		Firms heterogeneity	3.08 *** (0.52)	2.86 (0.24)	4.22*** (0.72)	2.51*** (0.31)

Notes: (*) significant at 10% level; (**) significant at 5% level; (***) significant at 1% level. Robust with Cluster (for country pair) Standard Errors in parenthesis.

Table 9: Econometric results by commodity group – Total EU imports

Dependent Variable	*Model*	*Estimated Coefficient*	*Commodity Groups*			
			Animal Products	Vegetable Products	Edible Oils	Prepared foodstuffs
Log (M_{ij})	**Benchmark gravity, OLS**	*Preference margin*	2.48 *** (0.40)	1.31 *** (0.30)	0.86 (0.99)	1.40*** (0.34)
Pr ($M_{ij} > 0$)	**Probit regression, marginal effects**	*Preference margin*	0.21 *** (0.07)	0.15 *** (0.04)	0.20 (0.15)	0.17*** (0.04)
Log (M_{ij})	**Heckman Selection**	*Preference margin*	1.39 *** (0.54)	2.01 *** (0.31)	-	2.03*** (0.35)
		Inverse Mills ratio(λ)	-	3.97 *** (0.42)	-	3.27*** (0.43)
		Firms heterogeneity	2.70 *** (1.01)	-	-	-

Notes: (*) significant at 10% level; (**) significant at 5% level; (***) significant at 1% level. Robust Standard Errors in parenthesis.

FIGURES

Figure 1: Share of EU agricultural tariff lines by type of tariff regime.

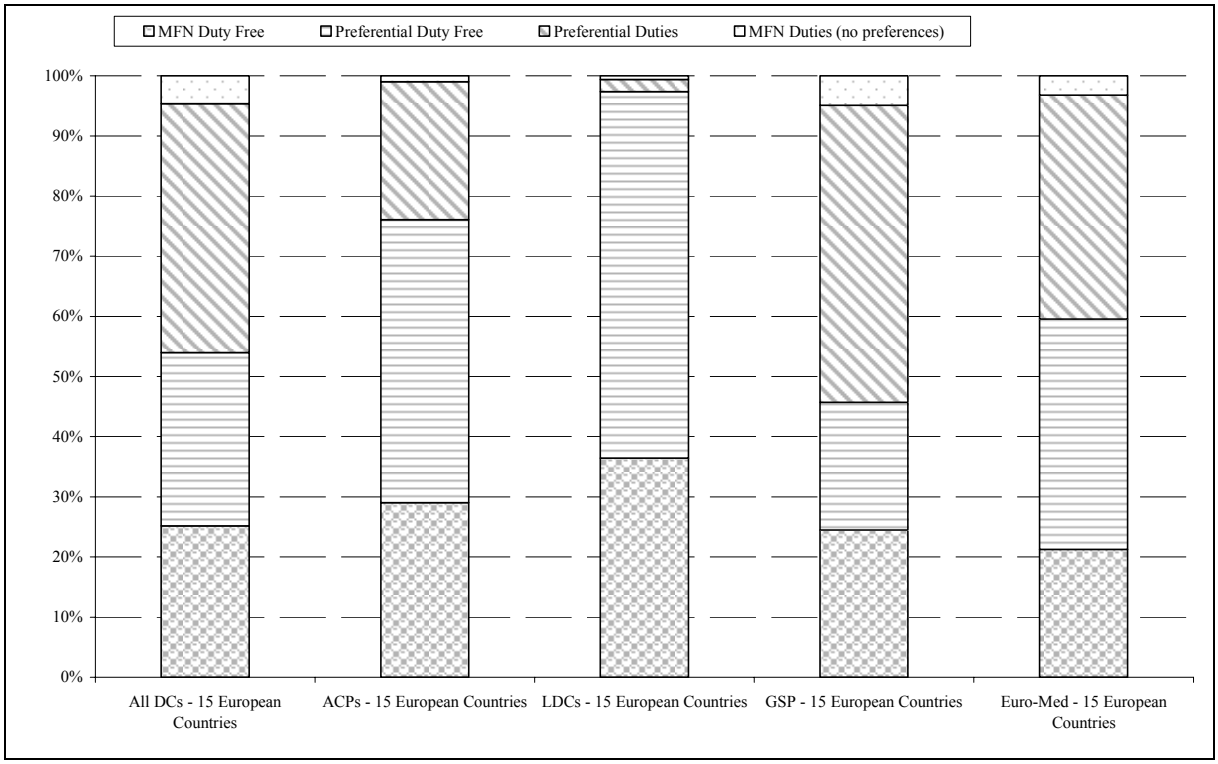

Figure 2: Positive and maximum preferences by sector

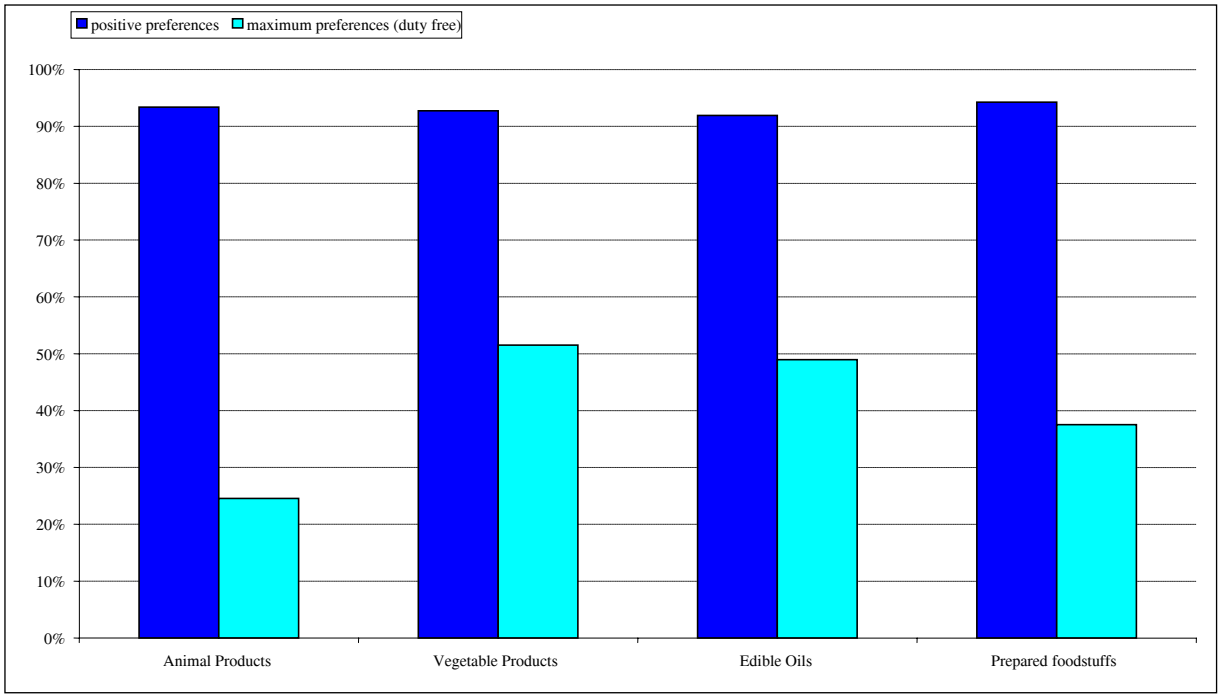

Figure 3: Distribution of EU MFN duties