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# The Impact of Regional Trade Agreements on Trade in Agricultural Products

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## Abstract

# The Impact of Regional Trade Agreements on Trade in Agricultural Products

*by*

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Trade flows are significantly affected by the trade agreements both with respect to impacts on pre-existing trade flows, (intensive margin) and on new, previously non-existent trade flows (extensive margin). The effect of the Regional Trade Agreements on pre-existing trade flows are found to be significant with a mean elasticity of substitution at the product level of about 2 so that a 1% preferential margin increases trade by only 2% on average. Total bilateral exports are found to be increased by 18% on average for products benefiting from a preferential margin between 5 and 10%, and by 48% for products where the margin exceeds 10%. The effect of an RTA agreement on extensive margin is to increase the probability to export a given a product to a partner country by one percentage point on average. Furthermore preferential margins, as measured through their impact on tax-inclusive consumer prices, nearly double within eight years of entry into force rising from 4.7% to 8.9% on average.

This study focuses on measuring the effects of tariff preferences accorded by agreement partners. It relies on trade and tariff data at a detailed product level for each of the 78 Agreements considered, over the period 1998-2009. The econometric assessment is based on difference-in-differences panel estimations, whereby exports to third destinations and imports from third origins are used as a benchmark when assessing the trade impact of RTAs between partners, product by product.

The authors thank Matthew Shearer, IADB, for use of data on tariff schedules by RTA.

***Key words***: Agricultural trade, extensive and intensive margins, regional trade agreements, preferential margins, econometric estimates.

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# Executive Summary

The share of global agro-food trade between countries with Regional Trade Agreements (RTAs) rose from slightly over 20% in 1998 to nearly 40% in 2009. Tariff concessions are among the key elements of these agreements, especially in agriculture, where tariff barriers are generally high.

This increasing importance of trade agreements raises a number of questions regarding their impacts on trade:

- Do the agreements increase trade among partners and if so by how much?
- Do they simply affect trade flows of existing traded goods or do they increase the probability of new trade flows, inexistent prior to the agreement?
- Do these impacts differ according to partners' income level? Do the impacts differ according to tariff reduction benefits offered, that is the preferential margin under the agreement?

To address these questions, this study focuses on measuring the effects of tariff preferences accorded by agreement partners. It relies on trade and tariff data at a detailed product level for each of the 78 Agreements considered, over the period 1998-2009. The econometric assessment is based on difference-in-differences panel estimations, whereby exports to third destinations and imports from third origins are used as a benchmark when assessing the trade impact of RTAs between partners, product by product.

## *Key findings*

This study finds that trade flows are significantly affected by the trade agreements both with respect to impacts on pre-existing trade flows, (intensive margin) and on new, previously non-existent trade flows (extensive margin):

- Preferential margins, as measured through their impact on tax-inclusive consumer prices, nearly double within eight years of entry into force rising from 4.7% to 8.9% on average. For South-South agreements the preferential margin is close to this average. North-South agreements display important asymmetries; South exports to the North (i.e. high-income OECD countries) receive a preferential margin of nearly 15% after eight years, while North exports to the South receive but a 4.2% preferential margin
- The effect of the agreements on pre-existing trade flows are found to be significant with a mean elasticity of substitution at the product level of about 2 so that a 1% preferential margin increases trade by only 2% on average. Total bilateral exports are found to be increased by 18% on average for products benefiting from a preferential margin between 5 and 10%, and by 48% for products where the margin exceeds 10%.

- The effect of an RTA agreement on extensive margin is to increase the probability to export a given a product to a partner country by one percentage point on average.

- The estimated impact of RTAs on North-South trade is found to be less for the North's exports with an elasticity of pre-existing trade flows of only 1.3 compared to 2 for the South's exports. The impact on the probability of new trade (extensive margin) is found to be small and of limited statistical significance for North countries but significantly higher in the case of South to North trade.

# The Impact of Regional Trade Agreements on Trade in Agricultural Products

The proliferation of regional trade agreements (RTAs) is likely to profoundly transform the established order of international trade. While multilateralism has stalled since the Uruguay Round, many new regional and bilateral agreements have come into being. The share of global agro-food trade between countries with Regional Trade Agreements (RTAs) rose from slightly over 20% in 1998 to nearly 40% in 2009. Tariff concessions are among the key elements of these agreements, though affecting all goods; these may have particularly far-reaching consequences for agricultural products which have high rates of protection relative to manufactured goods. While a number of other trade measures, such as tariff-quotas and non-tariff measures, are included in most agreements, these are not taken into account in the present analysis which focuses exclusively on tariffs.

The preferential margins are a key element in understanding the effects of these agreements because of their impacts on prices of traded goods. The preferential margins for the agro-food sector as measured through their impact on tariff-inclusive prices, nearly double within eight years of entry into force rising from 4.7% to 8.9% on average for the 78 RTAs analysed. While the preferential margin for South-South agreements is close to this average, North-South agreements display important asymmetries; South exports to the North (i.e. high-income OECD countries) receive a preferential margin of nearly 15% after eight years, while North exports to the South receive but a 4.2% preferential margin.

The increasing importance of trade agreements raises a number of questions regarding their impacts on trade: Do the agreements increase trade among partners and if so by how much? Do they simply affect trade flows of existing traded goods or do they increase the probability of new trade flows, inexistent prior to the agreement? In economics terminology, these latter questions refer simply to the impacts of RTAs on the intensive and extensive margins of trade. Do these impacts differ according to partners' income levels? Do the impacts differ according to tariff reduction benefits offered, that is the preferential margin?

Measuring the impact of regional trade agreements on trade flows is difficult, owing to the absence of a valid benchmark for comparison, since the evolution of trade flows in the absence of the agreements is unobservable. Econometric analysis can however partially address this issue: identifying the structural determinants of bilateral trade flows makes it possible to estimate what the level of trade between the partners would have been in the absence of the agreement. Thus, econometric estimation can provide a benchmark and allow us to assess more precisely the actual impact of the agreements on trade flows. The method used relies on reference groups to control for importer-exporter specific determinants. The changes over time in trade flows between the trading partners under an agreement can then be compared to the changes in trade flows with respect to

the reference groups. This difference-in- differences approach is then carried out at the product level.

The recent international trade literature has underlined the fact that the decision to export differs between firms and among products. Consequently, the analysis distinguishes between the impact of these agreements on pre-existing trade flows and on the creation of new flows. It also considers the extent to which these results vary between North (high income) and South (middle income) countries.

The study finds that the trade agreements affect pre-existing trade flows with a mean elasticity of substitution at the product level of about 2 so that a 1% preferential margin increases trade by 2% on average. The resulting impact is far from negligible, though: bilateral exports are found to be increased by 18% on average for products benefiting from a preferential margin between 5 and 10%, and by 48% for products where the margin exceeds 10%. Although small, the impact on the extensive margin, that is for new trades, is very weak: a 1% preferential margin increases the probability of exporting by 0.1 percentage point. On average, an RTA is found however to increase by approximately one and a half percentage point the probability to export a given product to the partner country.

Analysis of trade agreements by partner country income levels, designating high income OECD as "North" and all others as "South" countries reveals significant differences in their trade impacts: the impact on exports from the South is higher on both pre-existing trade (intensive margin) and on the probability of new trades (extensive margin), compared to agricultural exports from North countries.

Though estimates find positive trade impacts on both the intensive and extensive margin, much larger effects might have been expected given the tariff protection afforded the agro-food sector. This could mean that other trade measures continue to exert an impact trade flows. Further research is needed to understand better the reasons underlying these differences across agreements. The relatively low price elasticity of trade flows found in certain estimates also raises questions that would deserve further investigation.

This study responds to the request for an analysis of regional trade agreements in terms of their impacts on agro-food trade both in the aggregate and at the sector level. It complements and completes the study undertaken in collaboration with the Inter American Development Bank, on "The Treatment of Agriculture in Regional Trade Agreements" that examined nearly 100 agreements and simply asked how much additional market access they were bringing. It makes use of the initial tariff reduction schedules to build a more detailed data base, by product, by year and by agreement.

The paper is organised as follows. Section 1 provides a brief review of the literature and definition of the econometric approach; Section 2 summarises key elements of regional agreements and international trade flows; Section 3 discusses the results of the econometric analysis and Section 4 concludes and provides suggestions for future work.

# 1. Literature review and definition of estimation approach

In practice, the impacts of trade agreements are measured using so-called "gravity models". An extensive literature on these model types, starting with Tinbergen (1962), has not only demonstrated that they allow a relatively realistic representation of trade flows to be generated, but also that they are consistent with a wide array of theoretical frameworks for analysing international trade (see, in particular, Anderson, 1979; Bergstrand, 1989; Deardorff, 1998; Anderson and van Wincoop, 2003; Chaney, 2008; Anderson, 2010). As emphasised by Baldwin and Taglioni (2006), among others, very general assumptions are sufficient to yield gravity-type equations, making this a very flexible analytical framework.

This section briefly discusses these models and presents the estimation approach adopted in the present study to evaluate the impact of tariff preferences provided by the agreements on trade flows. This work should be considered as exploratory given the relatively new approach employed. A complete discussion of the econometric issues as well as derivation of the estimating equation and data transformations applied in the present study is found in Annex A.

## *Gravity models and their application to trade analysis*

The gravity model is most commonly estimated for evaluating determinants of trade flows.

The basic form of the gravity model is written

$$(1) \qquad \boldsymbol{X_{ijt} = G_t\, S_{it} \mathbf{M}_{jt} \phi_{ijt}}$$

where the indices *i*, *j* and *t* denote the exporting country, the importing country, and the year, respectively. **X** represents the value of the trade flow, **S** is a vector of the exporter's attributes, and **M** is a vector of the importer's attributes. The determinants of trade specific to each country pair are represented by the vector of variables $\boldsymbol{\phi}$. [1]

In the simplest version of the model, which is unfounded theoretically but most closely reflects the universal law of gravity in physics, **S** and **M** represent the respective GDPs of the trading partners and $\boldsymbol{\phi}$ the inverse of the distance. In practice, many other determinants of trade flows must be considered. This equation is most commonly used for the entire economy, but it can be applied across sectors.

This analytical framework has given rise to a prolific literature on the incidence of RTAs, of which recent overviews can be found in Cardamone (2007) and Salvatici and Cipollina (2010), for example. As many authors have emphasised, the results of these estimations are highly variable: while sometimes significantly negative, RTAs may also result in a doubling, tripling, or more of the initial flow of trade. Sensitivity analysis using the extreme bound analysis method reveals that these estimates are not robust (Ghosh and Yamarik, 2004). Not merely statistical in origin, however, this uncertainty springs from a series of conceptual problems. In fact, recent contributions to the literature have revealed that most of the older estimations were beset by errors. Some are easy to correct, like the

1. The multiplicative form of the equation implies that the influence of pair-wise specific transaction costs can be separated from exporter-importer specific attributes. This rules out pricing to market strategies whereby farm-gate prices of an exporter would vary across destinations.

problems underscored by Baldwin and Taglioni (2006) relating to a poor choice of deflator or work on a flawed calculation of the mean unidirectional trade flow between partner countries. Other problems that are more difficult to manage concern the econometric estimation method as discussed in Santos-Silva and Tenreyro (2006).

Aside from technical estimation issues, two fundamental problems of the simple gravity approach have been identified: multilateral trade resistance factors and endogeneity. The first major problem, raised first by Anderson and Wincoop (2007), is that specifications that rely only on economic masses of partners, such as GDP/GDP per-capita/population and fail to account for price terms, one for the exporting and one for the importing country, can introduce a potentially significant bias into the estimations. Correcting for these is important as biased estimates can potentially distort policy recommendations or conclusions derived from them.

The second major problem is that of endogeneity. There are likely to be a number of unobservable determinants that are likely to simultaneously affect the intensity of trade and the probability of an agreement and their omission can seriously affect estimation. Taken to the extreme, if we assume that the intensity of trade flows determines the probability of an RTA being signed causality is reversed. The probability that an agreement will be signed is contingent on the extent of the benefits that are likely to be had from the agreement which in turn are related to the impact of domestic policies or mutual compatibility on possibilities for trade between countries. In fact, selection bias often results for failure to account for this issue. The dichotomous indicator variable for an RTA most commonly used in the estimation of specifications such as equation (1) thus can no longer be considered independent of the error term, creating a bias in the estimates.

Most approaches for assessing the impact of RTAs on trade are all based on the use of a dichotomous indicator variable to indicate whether an agreement existed between the members or not. While the simplicity of this approach allows many agreements and countries to be studied simultaneously, it relies on several questionable assumptions:

- The one-off assumption: The use of an indicator variable presupposes that the impact of an agreement materialises instantaneously and completely upon its entry into effect. This is clearly unrealistic, since agreements always provide for a phase-in period, and their full impact is not immediately felt owing to the need to implement certain adjustments (some of which were anticipated) progressively.

- The uniformity assumption: When a large number of RTAs are jointly analysed, it is generally assumed that they all have the same impact. This simplification may be useful, but it is clearly unrealistic, since agreements differ in their scope, their preferential margin on customs duties, and a wide array of non-tariff provisions.

- The homogeneity assumption: Aggregate analysis is inherently unable to fully capture the complex structure of agreements, which do not all provide the same benefits for each good. In particular, preferential margins differ between goods, not only because their initial level of protection varies, but also because some goods are generally excluded from schedules of tariff concessions.

### *Transformation of the Dependent Variable*

To avoid the above common estimation errors raised in the literature the strategy adopted here is to transform the dependent variable to make use of the multiplicative structure of the model. This transformation makes the estimation amenable to interpretation as differences in differences in their logarithmic form. The differences in differences approach is commonly used to evaluate the outcomes of experiments where one group receives a treatment and the other does not. In this case the treatment group are the trade flows under bilateral trade agreements and the control group are bilateral trade flows without an agreement. They are, in fact, product-level differences between supplier countries and differences between export markets. Application of this method requires both an exporter control group and an importer control group. By choosing as control groups, for example, countries whose trade policy toward signatories did not change during the study period bilateral trade determinants with control groups can be assumed unchanged. Under general assumptions equation (1) then implies that movements in the difference in differences in trade flows can only be explained by trade liberalisation between the signatories (Annex A). This was done by Romalis (2007) to study the impact of NAFTA on trade between its signatories. This approach can be usefully applied to meet this study's specific estimation needs.[2]

Starting from the basic equation (1) and with appropriate transformations and simplification the estimated equation is:

$$(2) \qquad \mathbf{ln}\left(\boldsymbol{B_{ijkt}}\right) = \boldsymbol{\alpha_{ijk}} + \boldsymbol{\sigma}\mathbf{ln}\left(\frac{\boldsymbol{\tau_{ijkt}}}{\boldsymbol{\tau_{ljkt}}}\right) + \boldsymbol{\beta_{it}} + \boldsymbol{\gamma_{jt}} + \boldsymbol{u_{ijkt}}$$

Where $\mathbf{B_{ijkt}} = \left(\frac{\mathbf{X_{ijkt}}}{\mathbf{X_{i'jkt}}}\right) \Big/ \left(\frac{\mathbf{X_{ij'kt}}}{\mathbf{X_{i'j'kt}}}\right)$, *with i' the control group of exporter i and j' the control group of importer j*; u represents an error term and $\alpha_{ijk} = ln\left(\lambda_{ijk}\right)$. $\beta_{\mathrm{it}}$ and $\gamma_{\mathrm{jt}}$ are exporter-by-year and importer-by-year fixed effects, introduced to control for the possibility of country-specific factors in a given year.[3]

This specification includes one fixed effect specific to each exporter-importer-good triplet. As a consequence, estimated elasticities of substitution between imports from different origins ($\sigma$), assumed to be equal across products, only depend on changes over time within each of these triplets. Fixed effects by exporter, importer, or good, or by any combination of two of these dimensions, are implicitly accounted for. This approach permits estimation of the elasticity of the preferential margin on trade.

The estimators are robust to heteroskedasticity and serial correlation of the errors within each panel unit (i.e. each exporter-importer-good triplet). This type of estimation is however vulnerable to selection bias, since many trade flows are zero and are therefore not included in the estimation. In our case, this issue is compounded by the fact that trade flows involving the control groups may also be null, increasing the potential sources of

2. In different contexts, Hallak (2006) and Head et al. (2010) apply similar methods to trade flows, though they are aggregated in the second case. A simple transformation of the dependent variable by unit-by-unit division had previously been used in other work, in particular by Anderson and Marcouiller (2002), Hanson and Xiang (2004) and, more recently, Djankov et al. (2010).

3. We may, for example, consider variations in the bilateral exchange rate relative to the control groups. Given that these control groups are defined differently for each importer and each exporter, the corresponding fixed effects must be two-dimensional.

missing observations. The impacts of the preferential tariffs on the intensive margin are measured by limiting our estimation to importer-exporter-product triplets for which the flow of trade is not zero during any year of the sample, thus the period 2002-09 is chosen. This method allows minimizing the selection bias when estimating the effect of preferential agreements on pre-existing trade flows.

To measure the incidence of preferential tariffs on the extensive margin, we estimate the probability of exporting. As with estimations on trade flows, and for the same reasons, econometric modelling of this probability requires accounting for determinants specific to each (potential) exporter-importer-good triplet, as well as exporter-by-year and importer-by-year fixed effects. The retained specification is thus identical to that in equation (2) except for the endogenous variable, which is now the probability that exports are non-zero. We use a linear model to estimate the probability of exporting following the lead of Frazer and Van Biesebroeck (2010) and Head *et al.* (2010).

This method is demanding in terms of data, requiring panel data on annual trade flows, not only between the partners, but also between each partner *j* and control market *J*, and between the exporter control group *I* and the two markets *i* and *j*. For each good, annual data on the *ad valorem* equivalent (AVE) of tariff protection on market *j* for both partner *i* and the export control group *I* are also necessary.

## 2. Regional Trade Agreements and international trade flows

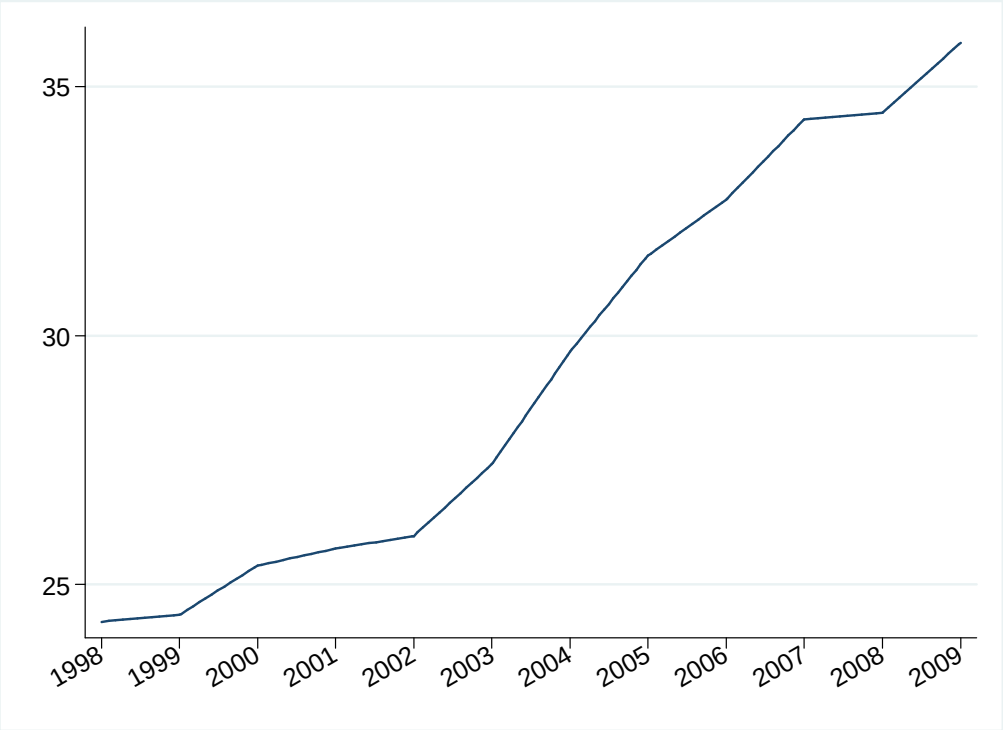
As discussed in the preceding section, detailed information allows for more precision and potentially better identification of the impact on trade of RTAs. Significant effort has been devoted to the analysis of relationship between the nature of RTAs and trade flows. The database developed provides for a detailed description of the role played by RTAs in the global trade of agricultural products.[4]

### *Regional Agreements in global trade*

It has become customary to point to the number of RTAs in effect to illustrate the importance of preferential agreements in international trade. However, not all agreements are created equal, so that a more direct measure for assessing the magnitude of the phenomenon would be useful. One simple indicator consists of measuring the share of global trade conducted between two partners having signed a trade agreement. From less than 24% in 1998, this share rose to over 36% in 2009 (Figure 1). Moreover, this remarkable growth showed no signs of slowing at the end of the period.

4. Owing to issues of data availability, the analysis is limited to the period 1998–2009.

**Figure 1. Share of trade between RTA signatories in global trade (%, all goods, 1998–2009)**

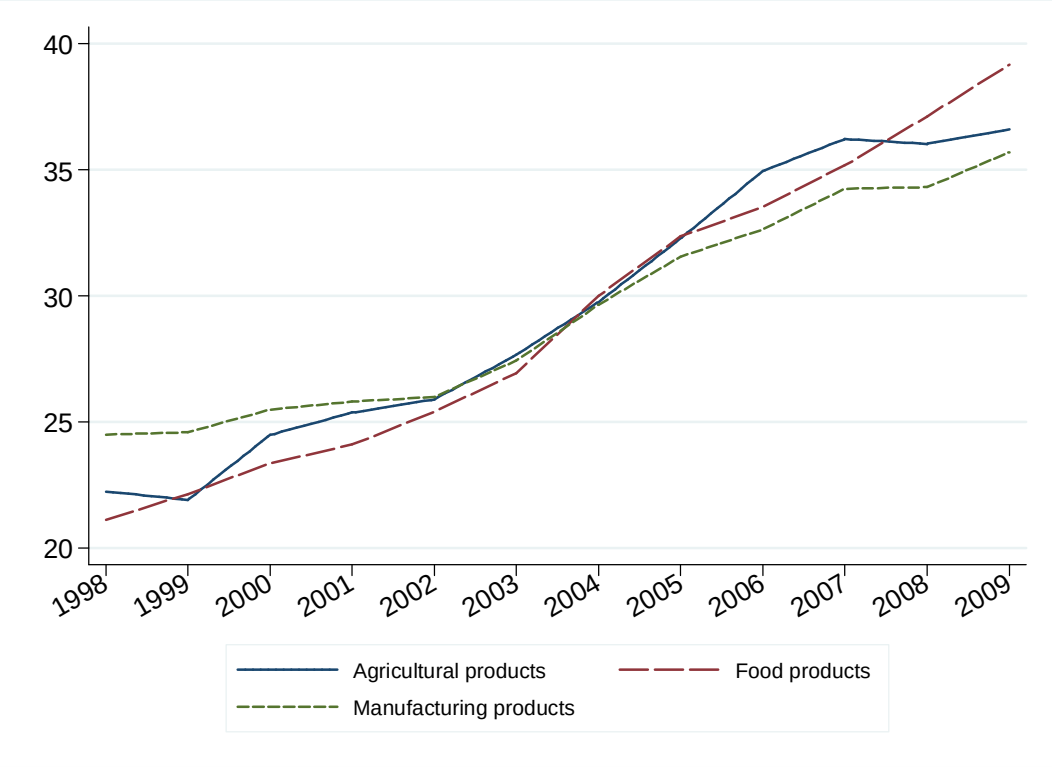



*Source:* Calculated by the authors from Comtrade's BACI (CEPII) database, the WTO RTA database, and additional information on RTAs from various sources.

An analysis by broad sector reveals that this general trend applies to a number of goods (Figure 2). We observe, however, that the share of global trade occurring between RTA partners was higher for manufactured products in 1998 but fell below that of agro-food products by 2009. This development has been most pronounced for unprocessed agricultural goods.

Clearly, this observation is purely descriptive, and should not be interpreted as implying causality. On one hand, trends observed over this period do not differ fundamentally across broad sectors. On the other hand, the accelerated pace recorded by the agricultural sector might at least partly reflect the greater intensity of agricultural trade between signatories to RTAs that entered into force between 1998 and 2009.

**Figure 2. Share of trade between RTA signatories in global trade, by major sector (%, 1998–2009)**




*Note*: Agricultural products are identified using the WTO definition. Of these, goods from Chapters 15-24+ are classified as food products.

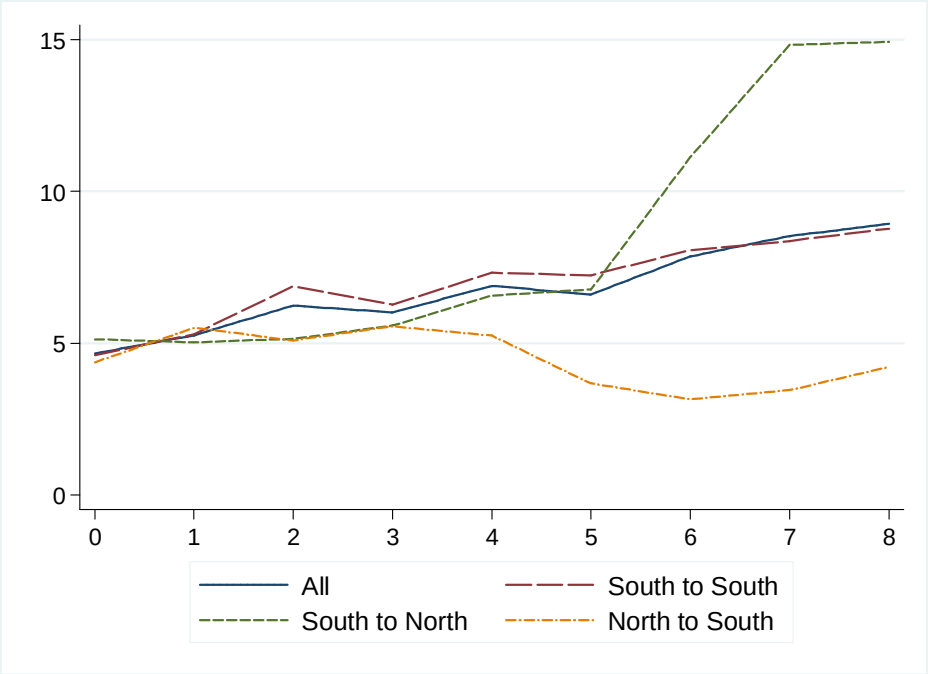
*Source*: Calculated by the authors from Comtrade's BACI (CEPII) database, the WTO RTA database, and additional information on RTAs from various sources.

Preferential trade agreements tend to include complicated provisions that vary over time and across goods. The net cast by these provisions covers much more than tariffs, but tariffs are of central importance to the agreements and the easiest to measure and compare. Thus, they are the focus of the present study.

The implementation of these agreements typically stretches out over some ten years, and the transition period sometimes even exceeds 15 years for specific products. Their cumulative impact on trade over time is not negligible. A detailed examination of the tariff concessions for agricultural and food products in the case of 78 RTAs, in conjunction with the *ad valorem* equivalents to the most favoured nation (MFN) import duties drawn from the MAcMap database at the six-digit product code level of the Harmonized System (HS) for the years 2001, 2004, and 2007, allows the average margin to be computed for each year from 1998 to 2009 (Figure 3).[5]

5. These averages are weighted by imports. To make these calculations possible, MFN import duties are assumed to have remained unchanged in all countries for the periods 1998–2001, 2002–2004, and 2005–2009.

**Figure 3. Mean preferential margin in percentage terms on agricultural goods by partner, according to the number of years following agreement implementation.**




*Note*: For *ad valorem* import duties $t_{MFN}$ under the MFN system and under the preferential system $t_{pref}$, the preferential margin is thus defined as $m = 1 - \left(1 + t_{pref}\right) / \left(1 + t_{MFN}\right)$. The agreements covered are not identically the same across the board, since the period elapsed since their implementation is variable. This explains why the preferential margin may, in some cases, diminish over time, which never occurs in the case of any agreement taken individually. High-income OECD countries are designated as "North" and all other countries as "South." Agreements are classified by exporter and importer category. The "South-to-North" category, for example, refers to concessions made by a North country to a South country within the framework of an agreement.

Field: goods defined as agricultural by the WTO; 78 bilateral agreements covered (see list in Appendix A).

*Source:* Calculated by the authors from BACI (CEPII) database, Comtrade (UN), MAcMap-HS6, and IDB data.

Our calculations reveal that, in the case of agreements for which information is available (Appendix A), the mean preferential margin[6] nearly doubles within eight years of its entry into force, rising from 4.7% during the first year to 8.9% eight years later.

We fine-tune our analysis by distinguishing between two groups of partner countries: high-income members of the OECD (or, simply, the "North") and the others (the "South"). This distinction reveals that preferential margins granted by agreements between countries of the South are near the mean calculated for all agreements. Conversely, North-South agreements are asymmetric, especially after several years: margins granted by countries of the North are higher (14.9 percentage points eight years

6. The term "preferential margin" is used here to designate the price wedge (taxes included) attributable to preferential treatment. For *ad valorem* import duties under the MFN system ($t_{MFN}$) and under the preferential system ($t_{pref}$), this margin is thus defined as $m = 1 - \left(1 + t_{pref}\right) / \left(1 + t_{MFN}\right)$ or, in terms of our earlier notation, $m = 1 - \tau_{pref}/\tau_{MFN}$ .

after implementation) than those granted by countries of the South (4.2 points after eight years).[7]

A similar calculation demonstrates the differences between the chapters of the Harmonized System (Table 1). Significant variation is evidenced, since the average preferential margin eight years after implementation of the agreement ranges from only a few points for the agricultural sector goods skins, and fur (Chapters 41 and 43), oilseeds (Chapter 12), and gums and resins (Chapter 13) to as high as 18 percentage points for cocoa and cocoa preparations (Chapter 18) and near 13 for miscellaneous edible preparations (Chapter 21), preparations of meat and fish (Chapter 16), beverages (Chapter 22), and preparations from vegetables (Chapter 20). The preferential margin exceeds 10 points in many other agricultural sectors. The inter-sectoral preferential margin differential also fluctuates considerably over time. Sectors that were most protected initially are often those with the highest preferential margin, as stands to reason, but they are also the sectors that create the greatest pressure to defer liberalisation.

**Table 1. Mean preferential margin by HS chapter, by the number of years since entry into force of the agreement (percentage points)**

| | Years since entry in force | | | | Years since entry in force | | |
|---|---|---|---|---|---|---|---|
| Chapter | 0 | 4 | 8 | Chapter | 0 | 4 | 8 |
| 1 | 3.6 | 5.0 | 6.0 | 15 | 3.5 | 5.9 | 7.7 |
| 2 | 14.6 | 16.2 | 11.8 | 16 | 4.1 | 9.1 | 13.1 |
| 4 | 8.4 | 6.8 | 11.4 | 17 | 5.9 | 8.2 | 9.1 |
| 5 | 2.7 | 3.8 | 6.1 | 18 | 4.4 | 7.6 | 17.8 |
| 6 | 5.0 | 6.3 | 7.8 | 19 | 5.3 | 7.4 | 10.7 |
| 7 | 7.6 | 9.8 | 10.1 | 20 | 8.2 | 9.1 | 12.7 |
| 8 | 5.8 | 7.6 | 10.4 | 21 | 7.4 | 10.8 | 13.2 |
| 9 | 4.6 | 6.0 | 7.6 | 22 | 6.0 | 10.0 | 12.9 |
| 10 | 2.7 | 7.7 | 9.2 | 23 | 4.7 | 8.2 | 7.6 |
| 11 | 3.1 | 6.3 | 10.5 | 24 | 8.4 | 9.9 | 12.2 |
| 12 | 3.2 | 3.7 | 4.5 | 28-38 | 3.2 | 5.3 | 7.8 |
| 13 | 3.7 | 4.2 | 5.6 | 41-43 | 3.1 | 2.4 | 3.2 |
| 14 | 3.3 | 4.2 | 6.8 | 50-53 | 3.1 | 4.0 | 6.4 |
| | | | | All products | 4.7 | 6.9 | 8.9 |

*Note*: The agreements covered are not necessarily the same across columns; in some cases the period elapsed since implementation was initially between 0 and 8 years, in other cases it fell short of 8 years at end of period.

*Source:* Calculated by the authors from BACI (CEPII) database, Comtrade (UN), MAcMap-HS6, and IDB data.

7. Only one North-North agreement is featured in our database, between the United States and Australia. Consequently, no results are presented for that category.

## 3. Econometric Analysis

To evaluate the impact of RTAs on international trade in agricultural products, the method described above is jointly applied to 78 agreements for which we have been able to obtain complete information on both the EAV of customs duties and the concession schedules. Products to which tariff quotas apply are ignored, since an approach based solely on import duties is inadequate for dealing with them. Estimations are run at the product level (six-digit product code level of the Harmonized System [HS6]).

Application of this method requires the creation of control groups specific to each importer and exporter. For a given country, the corresponding control group consists of all countries in our database[8] not having signed a preferential agreement with this country by 2009. For the sake of robustness, this group includes the entire population of countries which are meaningful points of comparison.[9] This composition is specific to each country, but stable over time.[10]

### *Estimation results*

#### *Intensive margin*

The key parameter of interest $\sigma$, the elasticity of import substitution. The elasticity of substitution between imports measures the product-level sensitivity of bilateral trade flows to the tariff-inclusive price wedge resulting from preferential tariff treatment, as specified in equation(2). The year of entry into force of the agreement may, however, be subject to some ambiguity: some agreements are implemented mid-year, in which case the first year is, *de facto*, only partially affected. This is why, in all estimations, the first year of entry into force of the trade agreement is estimated separately.

To avoid selection bias, in estimating the intensive margin effects of the agreements, we limit the estimation to importer-exporter-product triplets for which the flow of trade is non-null in each year of the sample. The sample is thus a balanced panel for the period 2002-09.[11]

respectively.

The import elasticity of substitution after the first year is estimated at -1.93: a preferential margin corresponding to a 1% decrease in the price increases trade by 1.93% relative to other suppliers (Table 2) estimation (1). First year impacts are very small and not statistically significant but are reported for completeness.

8. Our database excludes trade between two countries having signed a RTA when we do not have information on the nature of concessions granted by the accord.

9. Note that this approach differs from the randomized controlled trial's one, which is designed to cope with a context where not all meaningful points of comparison can be taken into account.

10. This approach does not exclude any trading agreements potentially concluded between members of different control groups. Given the large number of countries involved, we can assume that the corresponding changes are marginal. Moreover, they are largely controlled by exporter-by-year and importer-by-year fixed effects.

11. Estimations were also run on the entire period. These are available on request. Their results differ little from those presented here.

**Table 2. Estimation of the impact of preferential margins on bilateral trade**

| **Dependant variable:** | **Diff in diff log exports** | | **Export probability** | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Independent variable: Log price wedge linked to preferential duties** | | | | |
| *FTA's first year* | | | | |
| All agreements | -0.12 | | -0.05 ** | |
| | (-0.34) | | (-2.30) | |
| South-to-South | | 0.83 | | 0.08 ** |
| | | (0.80) | | (2.24) |
| South-to-North | | -0.31 | | -0.14 *** |
| | | (-0.72) | | (-4.04) |
| North-to-South | | -0.32 | | -0.07 * |
| | | (-0.45) | | (-1.76) |
| *Subsequent years* | | | | |
| All agreements | -1.93 *** | | -0.10 *** | |
| | (-5.00) | | (-7.84) | |
| South-to-South | | -2.02 ** | | -0.05 *** |
| | | (-2.37) | | (-3.88) |
| South-to-North | | -2.02 *** | | -0.23 *** |
| | | (-3.75) | | (-7.45) |
| North-to-South | | -1.34 ** | | -0.05 * |
| | | (-2.17) | | (-1.70) |
| Balanced panel | Yes | Yes | Yes | Yes |
| Adj. R-squared | 0.016 | 0.016 | 0.010 | 0.010 |
| Observations | 57,960 | 57,960 | 1,181,244 | 1,165,296 |
| Panel units | 7,245 | 7,245 | 98,437 | 97,108 |

*Notes*: "North" - High-income OECD countries; "South" - all other countries. Agreements are classified by exporter and importer category. Estimations using ordinary least squares. Student's t scores in brackets are robust to heteroskedasticity and the clustering of errors within each panel unit, i.e. each exporter-importer-product triplet. All effects refer to the impact at least one year after the entry into force of the agreement.

*Source*: Calculated by the authors from BACI (CEPII), Comtrade, and IDB data;2002-2009 Estimates 1-2 -;1998–2009, estimates 3-4; *,**,*** statistical significance levels 10% ,5% and 1%

To determine whether these effects depend on the income levels of partners, the agreements are again grouped into the broad North and South categories. Estimations are based on a balanced panel sample, Table 2 estimation (2). The estimated elasticity of substitution of imports to South countries is -1.34 whereas it is -2.02 for imports to North countries. The import elasticity of substitution between South- South countries is also approximately -2.02: a preferential margin corresponding to a 1 % reduction in the preferential tariff generates a 2% increase in trade relative to other suppliers. Thus the tariff reductions by North countries appear to generate more trade than do those granted by the South countries to the North. These values are smaller than expected from similar studies.

Given this relatively new approach to estimating trade effects, we compare our estimates with those of Romalis (2007), since our methodology is partly based on that paper. His estimates vary between -6.3 and -9.4 for US imports from Canada, between -9.6 and -10.9 for US imports from Mexico, between -2.8 and -5.5 for Canadian imports from the United States, between -6.6 and -8.1 for Canadian imports from Mexico, between -2.0 and -2.5 for Mexican imports from the United States, and between -0.5 and -0.7 (not significant) for Mexican imports from Canada. By way of comparison, our estimates seem consistent with these, though somewhat lower.

This impression is borne out by other detailed estimates that are available, even though none of them are specific to agriculture. Working with a very different methodology (based on the work by Feenstra, 1994), Broda and Weinstein (2006) find, for example, that the un-weighted mean of elasticities of substitution estimated for the United States between 1990 and 2001 is approximately –12.6 for goods at the ten-digit product code level of the Harmonized System (HS) (in comparison to only 4.0 for the three-digit product code level), for a median of –3.1 (–2.2 at three digits). Simonovska and Waugh (2011), using a methodology devised by Eaton and Kortum (2002), find approximately 4 for the same product code level as the one we use, HS6. Estimated import demand elasticities (at HS6) by Kee *et al.* (2008) equal –3.1 on average for all products.

### *Extensive margin*

To assess the incidence of preferential tariffs on the extensive margin, our estimations make use of a linear model of the probability of exporting, as described above. In this case, our sample is nearly twenty times bigger than previously, because triplets for which exports are nil are now included. For the same reason, the panel used for the estimations is naturally balanced.[12]

Our estimates confirm the impact of preferential tariffs on the probability of exporting. After the first year (for which is estimated effect is significant but only half as large as the one afterwards), the estimated effect over all agreements is relatively weak (-0.10), suggesting that a preferential margin that lowers the tariff inclusive price by 10% increases the probability of exporting by 1.0% (Table 2, estimation 3). However, distinguishing both across partners, North-South and South-South and preferential margin categories, reveals a wide heterogeneity, (Table 2, estimation 4). Our analysis suggests that preferential treatment has a stronger impact on the probability of exporting from South to the North countries (coefficient of -0.23) than for the South-South exports (coefficient of (-0.05).

### *Preferential margin categories*

A complementary approach for evaluating the impact of preferential treatment consists of grouping exporter-importer-good triplets into several categories, reflecting whether or not an agreement is in effect and, if so, the magnitude of the preferential margin. To do this, we create five categories: (i) no agreement is in place; (ii) an agreement with preferential margin equal to zero; (iii) the preferential margin is greater than zero, but less than 5%; (iv) the preferential margin is between 5 and 10%; (v) the

12. Except when some data are missing. In this case, the entire series is omitted. This notably affects instances in which the information available to us on preferential treatment in ambiguous. Products covered by tariff quotas are also omitted.

preferential margin is greater than 10%. In the econometric specification defined by equation(2), the level of tariffs is replaced by a series of dummies indicating belonging to one of these categories, with the first group serving as the reference. As previously, the first year of the implementation of each agreement is handled separately. For the sake of clarity, only the coefficients of the effects during subsequent years are presented.

Estimations indicate that an agreement does not materially affect trade creation for products that do not benefit from a preferential margin: we obtain a positive effect, which could reflect a boost provided by non-tariff measures, but it is not significant (Table 3, estimation 2, first line). Conversely, according to our results, entry into force of a trade agreement translates into a significant increase in bilateral exports relative to third countries in the case of good benefitting from a non-zero preferential margin. When this margin is less than 5%, the increase averages approximately 12% [exp(0.113)–1=12%], which is only significant at the 10% level. It rises to an average of 18% in the case of goods with a preferential margin ranging between 5% and 10%, and 48% for those benefitting from a margin exceeding 10%.

Distinguishing by agreement partner yields a pronounced positive impact when the margin exceeds 10% for all agreements, Table 3 estimation (2). It is weaker (and less significant) in the case of exports from the South to the North (+25%) and stronger for South-to-South flows (+93%). With lower preferential margins, there is a marked contrast between South-to-South exports, where the impact is always positive and substantial, and the others, for which the impact is not significant and often negative.

Estimation of the impact on the probability of exporting (extensive margin) provides further insights to these effects. When all agreements are considered jointly, entry into force of one of them does not modify the probability of exporting products not covered by tariff cuts, but increases this probability by 0.8% for products with a preferential margin that is positive but less than 5%, and by 1.5% when the preferential margin is greater than 5% (Table 3 estimation 3). Both impacts are statistically significant, but they vary widely across preferential margins as seen in Table 3 estimation 4. The impacts are strongest for South-South agreements, indeed there is a positive and significant impact even for products without preferential tariff cut. The impacts are of intermediate size and significant for South-South and South-North exports when preferential margins are greater than 5%. For North-South exports the impacts of the reduction in preferential margins is never significantly except where there is no reduction in the preferential margin and the impact is then negative.

These results parallel our findings for exports of goods that were already traded. The mean estimated impact of the agreements thus differs substantially by agreement type: South-to-South agreements greatly increase both trade in products that were previously traded by the partners and the probability of exporting new products; the increase in exports from the South to the North is, conversely, relatively minimal for goods that were already traded, but the probability of new exports rises sharply for product with a significant preferential margin; the impact for exports from the North to the South is concentrated on products already traded benefiting from a large preferential margin.

**Table 3. Estimation of the trade impact of preferential agreements, by level of preferential margin**

| **Dependant variable:** | **Diff in diff log exports** | | **Export probability** | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Independent variable:** | | | | |
| **Dummy variable indicating** | | | | |
| *PTA in force, but preferential margin = 0 for this product* | | | | |
| All agreements | 0.057 | | 0.000 | |
| | (0.90) | | (-0.08) | |
| South-to-South | | 0.585 *** | | 0.008 ** |
| | | (3.70) | | (2.22) |
| South-to-North | | -0.262 ** | | -0.003 |
| | | (-2.45) | | (-0.52) |
| North-to-South | | -0.001 | | -0.014 *** |
| | | (-0.01) | | (-3.19) |
| *0 < preferential margin < 5%* | | | | |
| All agreements | 0.113 * | | 0.008 *** | |
| | (1.95) | | (3.97) | |
| South-to-South | | 0.502 *** | | 0.014 *** |
| | | (4.27) | | (5.24) |
| South-to-North | | -0.137 | | -0.001 |
| | | (-1.26) | | (-0.19) |
| North-to-South | | 0.017 | | -0.003 |
| | | (0.16) | | (-0.55) |
| *5% < preferential margin < 10%* | | | | |
| All agreements | 0.166 *** | | 0.015 *** | |
| | (2.59) | | (7.02) | |
| South-to-South | | 0.496 *** | | 0.018 *** |
| | | (4.00) | | (6.77) |
| South-to-North | | -0.004 | | 0.016 *** |
| | | (-0.04) | | (2.88) |
| North-to-South | | -0.123 | | 0.006 |
| | | (-0.82) | | (0.86) |
| *10% < preferential margin* | | | | |
| All agreements | 0.389 *** | | 0.015 *** | |
| | (4.79) | | (5.91) | |
| South-to-South | | 0.659 *** | | 0.013 *** |
| | | (4.33) | | (4.27) |
| South-to-North | | 0.225 * | | 0.050 *** |
| | | (1.81) | | (6.98) |
| North-to-South | | 0.532 ** | | -0.015 |
| | | (2.34) | | (-1.55) |
| Balanced panel | Yes | Yes | Yes | Yes |
| Adj. R-squared | 0.016 | 0.016 | 0.010 | 0.010 |
| Observations | 57,960 | 57,960 | 1,181,244 | 1,165,296 |
| Panel units | 7,245 | 7,245 | 98,437 | 97,108 |

*Note*: "North" - High-income OECD countries; "South" - all other countries Agreements are classified by exporter and importer category. All estimates generated using ordinary least squares. Student's t scores brackets are robust to heteroskedasticity and the clustering of errors within each panel unit, i.e. each exporter-importer-product triplet. All effects refer to the impact at least one year after the entry into force of the agreement.

*Source*: Calculated by the authors from BACI (CEPII), Comtrade, and IDB data. 2002-09 estimates 1-2, 1998–2009-estimates 3-4; .*,**,*** statistical significance levels 10% ,5% and 1 % respectively.

## 4. Conclusions and future work

This analysis illustrates and assesses the increasing importance assumed by preferential trade agreements in the international trade of agricultural goods. Drawing on a database that details tariff concessions on agricultural products in a large number of agreements, it yields a portrait of their incidence in tandem with a progressive implementation which extends over a period exceeding ten years. It finds that the preferential margin for agricultural products is approximately 9% in agreements between South countries, while for agreements between North and South ( high-income OECD and others) the preferential margins granted by the former are considerably higher (approximately 15% on average) than those granted by the latter (approximately 4% on average, eight years after entry into force).

Estimating the impact of these agreements on trade involves many issues, owing to both the difficulty in correctly specifying the gravity equation that always underlies the estimations and problems of endogeneity arising from the fact that countries prioritise entering into these agreements with partners with whom they have other reasons to desire strong commercial ties. We address these difficulties by running estimations at the disaggregated level of individual products, only identifying relationships on the basis of trends in trade flows over time - not on cross-sectional comparisons of their intensities. Our estimates confirm the significant impact that preferential agreements have on trade in agricultural products. To limit selection bias, we separately estimate the impact on pre-existing trade flows (the intensive margin) and the impact on the probability of new trade flows arising (the extensive margin).

After the agreement has been in force for one year, we find a positive and significant impact in both cases. The elasticity of substitution between bilateral trade flows at the product level is relatively weak according to our estimates (on the order of two) and the positive impact on the probability of exporting is also moderate (with a coefficient of one-tenth). This means that on average a 1 % preferential margin increases pre-existing trade flows by 2% and increases the probability to export a given product to a partner country by .1%. By definition these average estimates do account for the peculiarities that might characterize some exporter-importer product triplets. Looking beyond the average effects, our analysis reveals significant differences between types of agreement: the positive impact is found to be stronger for South exports rather than for North exports. The analysis of these differences would be an interesting path to pursue for a greater understanding of the nature of the impact of preferential agreements on trade.

Future work, building upon this and previous Secretariat studies on the topic, could examine the differences noted between agreements, such as North-South and South-South to understand better the nature of the impacts of preferential agreements on trade flows. This could also include an analysis of their impacts on third countries as well as impacts on structure of trade. Such analysis would need to include the political economy dimension of the agreements in addition to refining the quantitative assessments of these agreements. Such analyses would contribute to understanding of growth in the network of RTAs and implications for agricultural policy.

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# Appendix A.

## List of the 78 agreements studied

Argentina-Bolivia (1997); Argentina-Chile (1996); Argentina-Colombia (2005); Argentina-Ecuador (2005); Argentina-Peru (2005); Argentina-Venezuela (2005); Australia-Chile (2009); Australia-Singapore (2003); Australia-Thailand (2005); Australia-USA (2005); Bolivia-Brazil (1997); Bolivia-Mexico (1995); Bolivia-Paraguay (1997); Bolivia-Uruguay (1997); Brazil-Chile (1996); Brazil-Colombia (2005); Brazil-Ecuador (2005); Brazil-Peru (2005); Brazil-Venezuela (2005); Brunei Darussalam-Chile (2006); Canada-Chile (1997); Canada-Costa Rica (2002); Canada-Mexico (1994); Canada-Peru (2009); Chile-China (2006); Chile-Costa Rica (2002); Chile-El Salvador (2002); Chile-Iceland (2004); Chile-Korea (2004); Chile-Mexico (1999); Chile-New Zealand (2006); Chile-Norway (2004); Chile-Paraguay (1996); Chile-Peru (1998); Chile-Singapore (2006); Chile-Switzerland (2004); Chile-Uruguay (1996); Chile-USA (2004); China-New Zealand (2008); Colombia-Paraguay (2005); Colombia-Uruguay (2005); Colombia-USA (2009); Costa Rica-Mexico (1995); Costa Rica-USA (2006); Dominican Rep.-USA (2006); Ecuador-Paraguay (2005); Ecuador-Uruguay (2005); El Salvador-Mexico (2001); El Salvador-USA (2006); EU27-Chile (2003); EU27-Egypt (2004); EU27-SACU (2000); Guatemala-Mexico (2001); Guatemala-USA (2006); Honduras-Mexico (2001); Honduras-USA (2006); Japan-Mexico (2005); Japan-Thailand (2007); Kenya-Tanzania (1994); Kenya-Uganda (1994); Korea-Singapore (2006); Mexico-Nicaragua (1998); Mexico-Uruguay (2004); Mexico-USA (1994); Morocco-USA (2006); New Zealand-Singapore (2001); New Zealand-Thailand (2005); Nicaragua-USA (2006); Panama-Singapore (2006); Paraguay-Peru (2005); Paraguay-Venezuela (2005); Peru-Thailand (2003); Peru-Uruguay (2005); Peru-USA (2009); Singapore-USA (2004); Turkey-Egypt (2004); Uganda-Tanzania (1994); Uruguay-Venezuela (2005).

The date in parenthesis refers to the year of entry into force of the Agreement.

# Annex A

# Review of the Literature and Definition of the Estimation Approach

## The gravity model and its standard application to the study of trade agreements

The basic form of the gravity model is written

$$\mathbf{(1)} \qquad X_{ijt} = G_t \, \mathbf{S}_{it} \mathbf{M}_{jt} \boldsymbol{\phi}_{ijt}$$

where the indices *i*, *j* and *t* denote the exporting country, the importing country, and the year, respectively. *X* represents the value of the trade flow, **S** is a vector of the exporter's attributes, and **M** is a vector of the importer's attributes. The determinants of trade specific to each country pair are represented by the vector of variables $\boldsymbol{\phi}$. In the simplest version of the model, which is unfounded theoretically but most closely reflects the universal law of gravity in physics, **S** and **M** represent the respective GDPs of the trading partners and $\boldsymbol{\phi}$ the inverse of the distance. In practice, many other determinants of trade flows must be considered. This equation is most commonly used for the entire economy, but it can be applied sectorially.

Once the relevant variables have been identified and an error term added, the model can be directly estimated. This model is usually estimated in log form:

$$\mathbf{(2)} \qquad \ln X_{ijt} = a \ln G_t + b \ln \mathbf{S}_{it} + c \ln \mathbf{M}_{jt} + d \ln \boldsymbol{\phi}_{ijt} + u_{ijt}$$

In general, evaluations of the impact of RTAs on trade are based on estimations of this type of model—with the fact that an RTA is in effect between the two partners being incorporated into the vector of variables $\boldsymbol{\phi}$:[13]

$$\mathbf{(3)} \qquad \ln \boldsymbol{\phi}_{ijt} = \ln \boldsymbol{\psi}_{ijt} + FTA_{ijt}$$

where $FTA_{ijt}$ is a dummy variable equal to one if an RTA is in effect between countries *i* and *j* at time *t*, and zero otherwise. The vector $\boldsymbol{\psi}_{ijt}$ designates the other determinants of bilateral trade at time *t*.

This analytical framework has given rise to a prolific literature on the incidence of RTAs, of which recent overviews can be found in Cardamone (2007) and Salvatici and Cipollina (2010), for example. As many authors have emphasised, the results of these estimations are highly variable: while sometimes significantly negative, RTAs may also result in a doubling, tripling, or more of the initial flow of trade. Sensitivity analysis using the extreme bound analysis method reveals that these estimates are not robust (Ghosh and Yamarik, 2004). Not merely statistical in origin, however, this uncertainty springs from a

13. If one, and only one, of the two partners are also in an RTA with a third country that may also be included so as to capture any potential diversion effect.

series of conceptual problems. In fact, recent contributions to the literature have revealed that most of the older estimations were beset by errors. Some are easy to correct, like the problems underscored by Baldwin and Taglioni (2006) relating to a poor choice of deflator or work on a flawed calculation of the mean unidirectional trade flow between partner countries.

Other problems that are more difficult to manage concern the econometric estimation method. Santos-Silva and Tenreyro (2006) demonstrate the bias inherent in estimating the model in its logarithmic form, owing both to heteroskedasticity and to a failure to fully, or even adequately, account for null flows. They show that it is preferable to estimate gravity models in their multiplicative form using the Poisson pseudo-maximum likelihood estimator. The appropriateness of this option for handling zero values has, however, been challenged, since the null flows considered by Santos-Silva and Tenreyro result from rounding, while many bilateral trade flows are actually nil owing to the non-negativity of the dependent variable (a problem that is particularly prevalent when estimations are performed at a disaggregated level). Martin and Pham (2008) demonstrate that, in this case, the Poisson method creates severe estimation bias, so that a two-stage Heckman procedure or, alternatively, an estimation that excludes zero values, is preferable. Burger *et al.* (2009) suggest, however, that the Santos-Silva and Tenreyro method can be amended by using econometric techniques that are more robust to the presence of a large number of null flows and to widely dispersed estimates (negative binomial distribution, zero-inflated models).

Aside from technical issues, two more fundamental problems have been identified: multilateral trade resistance factors (remoteness) and endogeneity.

## Two "structural" issues: Multilateral trade resistance factors and endogeneity

The first issue was identified by Anderson and van Wincoop (2003). Drawing on the structural foundations of the gravity model, they demonstrate that specifications that only consider the economic masses of the trading partners (whether in terms of their GDP [gross domestic product] or in terms of their *per capita* GDP and populations separately) fail to account for the price terms - one for the exporting country and one for the importing country - which are integral to the model. Anderson and van Wincoop show that this omission introduces a potentially significant bias into the estimations. They propose a method for estimating these terms, which they designate as multilateral trade resistance factors (the term "remoteness" is also used in the literature) in the sense that they constitute an aggregate measure of the disruption caused by barriers to the flow of trade between the two partners (see, for example, Anderson, 2010, for developments on this interpretation). In this case, the formulation and estimation are relatively complicated. Though Baier and Bergstrand suggest a simplified form, this also needs to be applied with caution in that its ability to effectively control for all factors that are specific to each trading partner depends on having the "true" model. A second way to account for remoteness, suggested by Anderson and van Wincoop (2003), consists of controlling this type of effect by assigning time-varying indicator variables to each partner. This specification does not allow trade resistance factors to be identified, but it does provide a simple method (independent of the model used) to ensure that they are controlled.

The second major problem is endogeneity. The creation of RTAs is notably motivated by missing variables that also contribute to determining the intensity of trade. Taken to the extreme, if we assume that the intensity of trade flows determines the probability of

an RTA being signed, causality is reversed. Even if we do not want to go that far, there will be a number of unobservable determinants that are likely to simultaneously affect the intensity of trade and the probability of an agreement. Baier and Bergstrand (2007) underscore that the rationale underlying RTAs is often to foster a sweeping integration of the signatories. The probability that an agreement will be signed is thus contingent on the extent of the benefits the partners hope to gain from such integration, which are in turn related to the impact of domestic policies (and their mutual compatibility) on possibilities for trade between the countries. Also, endogeneity can be a function of other omitted variables that impact on the probability of the creation of an agreement such as, for example, certain cultural and political ties between the trading partners, similar prospects, specific opportunities for trade and co-operation, formal and informal networks, and a wide array of other elements that are impossible to measure. The indicator variable for RTA can no longer be considered independent of the error term, creating a bias in the estimates.

Various methods are available for correcting this endogeneity. In cross-sectional estimation, the instrumental variables technique is most commonly used. However, Baier and Bergstrand (2007) conclude that instrumental variables are not very reliable in this case, in large part because it is difficult to find instruments having an incidence on the likelihood of signing a trade agreement but not on the intensity of bilateral trade. They also underscore the selection bias associated with the intensity of barriers to trade (such as domestic regulations or non-tariff barriers) that condition the potential benefits from an agreement. Methods based on Heckman control functions would allow this bias to be controlled, except that Baier and Bergstrand find that they are not applicable here, once again because of the difficulty finding variables that are correlated with the probability of the existence of an agreement but not with the intensity of trade. Another approach consists of matching, *i.e.* comparing a country pair that has signed an agreement with another pair that has not, despite the same *ex ante* probability of concluding a trade agreement according to the observable explanatory variables. Baier and Bergstand (2009b) obtain plausible results using this method. Aside from its intractability, it should be noted that this method requires a key assumption of conditional mean independence, according to which, for given control variables, the *a priori* expected value of trade flows between two partners with or without a trade agreement is independent of the actual existence of such an agreement. This assumption appears questionable, in the sense that the potential difference in trade intensity between the with- and without-agreement situations conditions the potential benefits, and thus the probability of signing an agreement.

Endogeneity is easier to control when estimations are on panel data. The principal unobservable determinants of trade, which also condition the probability of signing an agreement, can be assumed to vary little over time. Therefore, these effects can be controlled with country-pair-specific fixed effects, yielding unbiased estimators of the agreement's impact on trade even if the unobservable variables are correlated with the probability of the existence of an agreement. Applying this method to a structural model, Baier and Bergstrand (2007) obtain estimates suggesting that, on average, an RTA approximately doubles the level of trade between the partners. Estimates by Gaulier *et al.* (2004) are consistent with that order of magnitude, as are those obtained by Carrère (2006) using a different, though compatible, panel method.

## Beyond the dichotomous approach: Accounting for variability in the impact of RTAs over time and space and across products

The methods for assessing the impact of RTAs that we have mentioned so far, which represent the bulk of the literature, are all based on using a dichotomous variable to indicate whether an agreement existed between the members. While the simplicity of this approach allows many agreements and countries to be studied simultaneously, it relies on several questionable assumptions:

- The one-off assumption: The use of an indicator variable presupposes that the impact of an agreement materialises instantaneously and completely upon its entry into effect. This is clearly unrealistic, since agreements always provide for a phase-in period, and their full impact is not immediately felt owing to the need to implement certain adjustments (some of which were anticipated) progressively.
- The uniformity assumption: When a large number of RTAs are jointly analysed, it is generally assumed that they all have the same impact. This simplification may be useful, but it is clearly unrealistic, since agreements differ in their scope, their preferential margin on customs duties, and a wide array of non-tariff provisions.
- The homogeneity assumption: Aggregate analysis is inherently unable to fully capture the complex structure of agreements, which do not all provide the same benefits for each good. In particular, preferential margins differ between goods, not only because their initial level of protection varies, but also because some goods are generally excluded from schedules of tariff concessions.

Some of these points have been addressed in previous work. Thus, the one-off assumption can be avoided by modelling the impact of the agreement as being staggered over a long period (for example, two consecutive five-year periods in Baier and Bergstrand, 2007), and even by examining how the profile of the incidence of these agreements evolves over time (Carrère, 2006). To avoid the uniformity assumption, many studies look at a limited list of agreements and consider each one individually.

The homogeneity assumption is particularly troublesome in the case of agricultural products, which frequently receive special treatment, both because they typically benefit from a high initial level of protection and because of their sensitive nature. Using estimations on panel data with country-pair-specific fixed effects and country-specific time-varying fixed effects, Grant and Lambert (2008) confirm this intuition by demonstrating that trade creation is substantially greater for agricultural products than for non-agricultural products. If we let the transition period for implementation last up to 12 years, the mean estimated impact is an increase of nearly 150% in bilateral trade of agricultural goods between signatories, versus only +63% for non-agricultural goods. The impact varies widely across the agreements examined: it is particularly high in the case of the EU (+400%) and the Andean Pact and the Closer Economic Relations agreement between Australia and New Zealand (nearly +300% in both cases), but not in the case of NAFTA (the North American Free Trade Agreement) or, especially, Mercosur and ASEAN (Association of South-East Asian Nations).

Types of product differentiation other than those specific to agricultural goods should be considered, though that requires extremely detailed information. Tariffs are set by tariff lines and vary from one schedule of preferential treatment to the next. Drawing on information in the 2004 MAcMap database, Cipollina and Salvatici (2007) perform estimates based on the size of each product's preferential margin. In the more specific

framework of European fruits and vegetables, Emlinger *et al.* (2008) also explicitly incorporate tariff levels into their estimations. In both cases, however, these are cross-section studies.

## Transformation of the dependent variable

One strategy consists of transforming the dependent variable. This was done by Romalis (2007) to study the impact of NAFTA on trade between its signatories.[14] His transformations make use of the multiplicative structure of the model. Amenable to interpretation as differences in differences in their logarithmic form, they are, in fact, product-level differences between supplier countries and differences between export markets. Application of this method requires both an exporter control group and an importer control group. By choosing as control groups, for example, countries whose trade policy toward NAFTA signatories did not change during the study period, movements in the difference in differences can only be explained by trade liberalisation between the signatories. Using data on product-level tariffs, this method is good for identifying the agreement's impact on trade, since all terms that are specific to the supplier or the importer disappear from the model.

Unit-by-unit division of equation (1) for two exporting countries *i* and *i'* and for a given product *k*, yields:

**(4)** $$R_{ii'jkt} = \frac{x_{ijkt}}{x_{i'jkt}} = \frac{S_{ikt}}{S_{i'kt}} \frac{\phi_{ijkt}}{\phi_{i'jkt}}$$

where *R* is the ratio of country *j*'s imports in sector *k* from suppliers *i* and *i'* respectively. This formulation allows the general term *G* to be eliminated, as well the term *M* representing the attributes of the importer. If we let exporter-specific attributes be invariant (or vary at the same relative rate regardless of the sector), this equation allows the evolution over time of the determinants of the bilateral intensity of trade, $\Phi$, to be identified, provided the bilateral determinants of trade are constant in the case of partner *i'*.

If we let exporters' attributes change over time (for example, under demand pressures induced by the agreement), then these variations can be controlled by examining the relative volume of imports from suppliers *i* and *i'* (labelled B, for BI-ratio) on markets *j* and *j'*, obtained by dividing equation (4)) unit by unit for each of market *j* and *j'*:

(5)
$$B_{ii'jj'kt} = \frac{R_{ii'jkt}}{R_{ii'j'kt}} = \left(\frac{x_{ijkt}}{x_{i'jkt}}\right) \Big/ \left(\frac{x_{ij'kt}}{x_{i'j'kt}}\right) = \left(\frac{\phi_{ijkt}}{\phi_{ij'kt}}\right) \Big/ \left(\frac{\phi_{i'jkt}}{\phi_{i'j'kt}}\right)$$

This equation allows the impact that a bilateral agreement has on trade between the partners to be identified. In fact, making the standard assumptions (notably, perfect competition and goods that are differentiated by country of origin), and letting

14. In different contexts, Hallak (2006) and Head et al. (2010) apply similar methods to trade flows, though they are aggregated in the second case. A simple transformation of the dependent variable by unit-by-unit division had previously been used in other work, in particular by Anderson and Marcouiller (2002), Hanson and Xiang (2004) and, more recently, Djankov *et al.* (2010).

transportation costs be written as the product of a time-specific fixed effect and a sector-specific fixed effect, the bilateral term for trade flow intensity can be written:[15]

$$\boldsymbol{\phi_{ijkt} = a_{ijk} b_t c_k \tau_{ijkt}^{\sigma}} \quad \textbf{(6)}$$

where $\tau-1$ is the *ad valorem* customs duty applied by country *j* to imports of good *k* from supplier *i* at time *t*. $\sigma$ designates the elasticity of substitution between varieties of good *k*. So we see that estimating this elasticity reveals the impact a given bilateral tariff reduction will have on trade between the signatories versus trade with other countries. Substituting(5) into (6)) yields:

$$\boldsymbol{B_{ii'jj'kt} = \left[\left(\frac{a_{ijk}}{a_{i'jk}}\right)\Big/\left(\frac{a_{ij'k}}{a_{i'j'k}}\right)\right]\left[\left(\frac{\tau_{ijkt}}{\tau_{ij'kt}}\right)\Big/\left(\frac{\tau_{i'jkt}}{\tau_{i'j'kt}}\right)\right]^{\sigma}}. \quad \textbf{(7)}$$

Now, let the indices *i* and *j* represent two partners having signed a bilateral trade agreement. Also, let *j* denote a control market $[j' = J(i)]$ consisting of a representative set of countries whose trade policy vis-à-vis country *i* has not changed during the period under study $[\tau_{iM(i)kt} = \tau_{iM(i)kt_0}]$. Finally, let *i'* be a control group of exporters $[i' = I(j)]$ consisting of trading partners such that the trade policy of both country *j* and the control market toward *i'* has remained unchanged during the period under examination $[\tau_{X(j)jkt} = \tau_{X(j)jkt_0},\ \tau_{X(j)M(i)kt} = \tau_{X(j)M(i)kt_0}]$. Under these conditions, the ratio of import duties applied by the reference importer *M* to suppliers *j* and *X* does not change over time. Assuming that the elasticity of substitution $\sigma$ does not depend on the sector, equation (5) can be rewritten:

$$\boldsymbol{B_{iIjJkt} = \lambda_{ijk} \tau_{ijkt}^{\sigma}} \quad \textbf{(8)}$$

where $\lambda_{ijk} = \left[\left(\frac{a_{ijk}}{a_{Ijk}}\right)\Big/\left(\frac{a_{ijk}}{a_{IJk}}\right)\right]\left[\left(\frac{1}{\tau_{ijkt_0}}\right)\Big/\left(\frac{\tau_{Ijkt_0}}{\tau_{IJkt_0}}\right)\right]^{\sigma}$. *I* and *J* designate $I(j)$ and $J(i)$, so that *B* only depends on *i*, *j* and *k*. Traditionally, this type of equation has been estimated in log-linear form:

$$\boldsymbol{\ln\left(B_{ijkt}\right) = \alpha_{ijk} + \sigma \ln\left(\frac{\tau_{ijkt}}{\tau_{ilkt}}\right) + \beta_{it} + \gamma_{jt} + u_{ijkt}} \quad \textbf{(9)}$$

where *u* represents an error term and $\alpha_{ijk} = \ln(\lambda_{ijk})$. $\beta_{it}$ and $\gamma_{jt}$ are exporter-by-year and importer-by-year fixed effects, introduced to control for the possibility of country-specific factors in a given year.[16] This specification includes one fixed effect specific to each exporter-importer-good triplet. As a consequence, estimated elasticities of substitution between imports from different origins ($\sigma$) only depend on changes over time within each of these triplets. Fixed effects by exporter, importer, or good, or by any combination of two of these dimensions, are implicitly accounted for. It is superfluous to incorporate them explicitly since they would be perfectly correlated with the fixed effects already included.

As we have already emphasised, the Santos-Silva and Tenreyro (2006) approach is impracticable for large panels like the one we use here, and it is also unsatisfactory when there are many null flows, as is the case when estimations are conducted at a

15. This type of expression can, for example, be derived from the Romalis model (2007).

16. We may, for example, consider variations in the bilateral exchange rate relative to the control groups. Given that these control groups are defined differently for each importer and each exporter, the corresponding fixed effects must be two-dimensional.

disaggregated level. Therefore, our estimations are based on the logarithmic form and use estimators that are robust to heteroskedasticity and serial correlation of the errors within each panel unit (i.e. each exporter-importer-good triplet).

This type of estimation is vulnerable to selection bias, since many trade flows are zero and are therefore not included in the estimation. In our case, this issue is compounded by the fact that trade flows involving the control groups may also be null, increasing the potential sources of missing observations. As the recent international trade literature has clearly demonstrated (see, for example, Chaney, 2008, or Helpman et al., 2008), it is important to account, not only for tends in existing trade flows (the intensive margin in trade), but also for developments in the number of goods traded (the extensive margin).

We begin by focusing on the intensive margin, limiting our estimation to importer-exporter-product triplets for which the flow of trade is not zero during any year of the sample. An unbiased estimation of the effect of preferential agreements on pre-existing trade flows can be obtained in this manner.

Next, turning our attention to the incidence of preferential tariffs on the extensive margin, we estimate the probability of exporting. As with estimations on trade flows, and for the same reasons, econometric modelling of this probability requires accounting for determinants specific to each (potential) exporter-importer-good triplet, and well as exporter-by-year and importer-by-year fixed effects. The retained specification is thus identical to that in equation(2), except for the endogenous variable, which is now the probability that exports are non-zero. Given the large size of the sample, accounting for fixed effects by panel unit is only possible using a Within estimator—explicitly incorporating all the dummies is numerically intractable. Following the lead of Frazer and Van Biesebroeck (2010) and Head et al. (2010), we thus use a linear model to estimate the probability of exporting.

This method is demanding in terms of data, requiring panel data on annual trade flows, not only between the partners, but also between each partner *j* and control market *J*, and between the exporter control group *I* and the two markets *i* and *j*. For each good, annual data on the *ad valorem* equivalent (AVE) of tariff protection on market *j* for both partner *i* and the export control group *I* are also necessary.