

Colombian agricultural product competitiveness under the free trade agreement with the United States: analysis of the comparative advantages¹

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Abstract

This article studies the competitiveness of Colombian agricultural products relative to those of the United States, with a view to assessing the extent to which the free trade agreement between the two countries represents a risk or an opportunity for Colombia. Colombia's revealed comparative advantages, in the trade zone it forms with the United States, are calculated for 60 groups of agricultural products and their derivatives, chosen from the Standard Classification for International Trade (SITC), using the method of the Center for International Prospective Studies and Information (CEPII). Most of the product groups display no comparative advantage or comparative disadvantage, so their competitiveness needs to be strengthened to enable trade in agricultural products with the United States to really contribute to the growth of the Colombian economy.

Keywords

Agricultural products, competitiveness, comparative advantage, measurement, free trade, treaties, Colombia, United States

JEL classification

F15, F63, O13

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I. Introduction

Colombian foreign policy is founded on a deep alignment with the United States (Londoño, 2011), as manifested in the way Colombia has conducted its international relations with the United States throughout history. Since the end of the First World War, Colombia has viewed the United States as the north star guiding its course, as the main destination for its exports, especially coffee (Iannariello-Monroy, Leon and Oliva, 1999). Successive Colombian governments have viewed that country as a source of foreign exchange and financial aid for development, which has encouraged them to consolidate relations and thus preserve their benefits (Romero, 2006; Londoño, 2011). Since then, Colombia has participated in various United States initiatives such as the Alliance for Progress (1967), the Jumbo, Concorde, Challenger and Hercules support packages (respectively, 1985, 1987, 1989 and 1991), the Andean Trade Preference Act, Plan Colombia (1999) and the Andean Trade Promotion and Drug Eradication Act (ATPDEA, 2002) (Díaz Rivillas, 2002; Swanson, 2006; Toscano, 2012).

The entry into force of the free trade agreement (FTA) between these two historical partners, on 15 May 2012, is the most recent episode and represents a continuation of the aforementioned historical pattern. In general, the FTA is divided into two parts: the first part (chapters 2 to 8, the first chapter being an introduction) deals with merchandise trade; the second (chapters 9-22) addresses a number of considerations related to merchandise trade, such as public procurement, trade in services, foreign direct investment (FDI), intellectual property, labour, and the environment. In the first part, the FTA provides for the immediate or progressive elimination of customs tariffs and non-tariff barriers (such as import restrictions) on a long list of agricultural products and their derivatives (hereinafter referred to as “agricultural products”), namely livestock, fishery, forestry, agriculture and hunting products, along with food and beverages.

The negotiations on those products, which began in 2004, were overshadowed by doubts as to Colombia’s real chances of being able to compete with the United States. Even after the signing of the treaty in 2006 and its approval by the Colombian Congress in 2007, concerns remained over the risks to small-scale farmers and certain products in which the terms agreed upon in the negotiations were considered unfair (Umaña and Caro, 2004; Umaña, 2005; Moncayo, 2006; Pesquera and Rodríguez, 2009). Lack of competitiveness risks triggering a process whereby imports from the United States substitute Colombian agricultural production. This would have an adverse impact on employment and income, particularly in rural areas; and it would also prevent Colombian agricultural products from contributing to economic growth by increasing net exports to the United States (Awokuse, 2008).

Studies evaluating the competitiveness of Colombian agricultural products under the FTA are few. Most of them estimate the effects of the treaty on Colombian agricultural production in terms of trade flows, growth, resource allocation, prices or productivity, among other variables, using either general equilibrium models (DNP, 2003; Martín and Ramírez, 2005; Durán Lima, De Miguel and Schuschny, 2007; Gracia and Zuleta, 2009; Toro and others, 2010; Umaña, 2011; Hernández, 2014); gravity models (Cárdenas and García, 2004 and 2005; Lozano, Castro and Campos, 2005); or econometric models (Cano and others, 2012; Díaz Valencia, 2012). However, regardless of the method used, these studies do not address the competitiveness of Colombian agricultural products explicitly, but instead consider the effects of the treaty.

Against this backdrop, the current study seeks to evaluate the competitiveness of Colombian agricultural products relative to their United States counterparts, using the CEPII indicator (De Saint-Vaulry, 2008). Comparative advantage is defined as the ability to produce a good or service at a lower relative cost (as originally proposed by Ricardo) or by differentiating its characteristics to make it more competitive (Lafay, 1987). The CEPII indicator measures comparative advantages in a standard way,

revealed through an analysis of observed trade patterns, as proposed by Balassa (1965). The use of the CEPII method is justified because it can be seen as the most highly developed means of measuring comparative advantages through trade.

As far as the authors are aware, in the few studies that exist on the competitiveness of Colombian agricultural products, the following two criteria are not applied simultaneously: (i) a study focusing on the bilateral trade zone between Colombia and the United States; and (ii) a study performed using the CEPII revealed comparative advantage (RCA) index. Firstly, studies that measure competitiveness are not referenced on the aforementioned trade zone (first criterion) (World Bank, 2003; Leibovich and Estrada, 2008; Norton and Argüello, 2008; Perfetti, 2011; Danna-Buitrago, 2012; Maldonado and Sánchez, 2012; Reina and others, 2013; Danna-Buitrago and Stellan, 2014). In addition, although Rocha Beltrán (2012) is an exception, this author only measures the comparative advantages of seven agricultural products (wheat, rice, maize, soya, tobacco, potatoes and cotton), rather than a complete nomenclature of products in that sector. So, regardless of their content, the results obtained in these studies do not address the focus of this research. Secondly, although an index similar to an RCA index is used in these studies (albeit not always), it does not take account of the improvements made by CEPII (second criterion).

In short, the present research aims to identify the competitive profile of Colombian agricultural products with respect to those of the United States in an original and systematic way. After calculating the RCA index for 60 groups of agricultural products, as specified in the International Standard Classification for International Trade (SITC), observed trade patterns reveal comparative advantages that are sustainable through time for just three of them, while four others have the potential for such sustainability. The other groups either have no advantage or else have disadvantages. Consequently, Colombia has few opportunities to exploit the benefits of free trade in agricultural products with its historical partner, so it is essential to enhance their competitiveness.

The article is divided into six sections, including this introduction. Section II describes the modalities of liberalization of agricultural trade between the parties. Section III presents the CEPII method to calculate the RCA index, based on other methods considered representative in the literature, with the aim of highlighting the improvements introduced by CEPII. Section IV explains the calculation parameters; and section V presents the calculations and analyses the results. To conclude, section VI summarizes the results and suggests future lines of research.

II. Agricultural trade liberalization within the FTA

Trade in agricultural products is governed by the first part of the FTA, which includes a number of commitments to eliminate import restrictions and export subsidies, and to grant imported goods a treatment that is at least as favourable as that accorded to nationally produced goods (Espinosa and Pasculli, 2013). The key liberalization measure is the total, immediate or progressive elimination of customs tariffs (Article 2.3 of the FTA), such that Colombia and the United States will trade agricultural products tariff-free by 2031 (except for sugar and its derivatives, as will be explained later).

Since the FTA entered into force in 2012, tariffs have already been completely eliminated on most agricultural products, as can be seen from a detailed analysis of the tariff reduction schedules provided for by the FTA in the two existing lists for each country.² Although the first list is called “Agricultural goods”, the items it includes are not exclusively agricultural, nor does it include all

² See the lists available [online] <http://www.tlc.gov.co/publicaciones.php?id=727>.

agricultural products. Some of these are in the second list, called “Non-agricultural goods”, which, despite the name, includes agricultural items such as fishery products and some non-edible raw materials of animal or vegetable origin (natural rubber, wood and natural fibres, among others).

These lists classify products in different groups identified by codes that are not homogeneous across the two countries, but have a common base. Frequently, two or more United States groups correspond to the disaggregation of one Colombian group, or vice versa. For example, Colombia has one group called for aubergines (*berenjenas*) (07093000), while United States has two aubergine groups: those entering the country between 1 April and 30 November of each year (07093020) and those entering between 1 December and 31 March of the following year (07093040). The United States tariff schedule also has one group for birds’ eggs (04070000), while Colombia has three groups covering this product: hatching eggs (04070010), eggs for the production of vaccines (04070020) and other birds’ eggs (04070090).

Defining the correspondences between the Colombian and United States groups reveals 859 “metagroups”, in other words a set of Colombian groups and an equivalent set of United States groups, without both sets necessarily having an identical level of disaggregation (as in the two foregoing examples). In 644 (75%) of these metagroups, all Colombian groups belong to category “A” (or “AA” in the case of a single group), while all United States groups belong to categories “A” or “F”. The first category (as well as “AA”) indicates an immediate total elimination of tariffs. The “F” category, available only to the United States, represents tariff-free groups prior to signing of the FTA, under ATPDEA; so the FTA allows it to keep some tariff benefits that would otherwise have had to lapse in 2011.

Among the remaining metagroups, there are 102 in which Colombian groups do not belong exclusively to category “A”, but some are in category “B”. This means that, instead of an immediate tariff elimination, a five-year phase-out from a base tariff is introduced; and 2017 is set as the year in which these products will become duty-free. At the same time, the American groups in these 102 metagroups belong to the “A” or “F” categories (as in the 644 metagroups mentioned above). There are also two metagroups in which Colombian groups belong only to category “A”, while some United States groups are in category “B” instead of categories “A” or “F”. In short, in 748 or 87.1% of the 859 metagroups, tariff elimination had already been implemented in 2012, or else it was to be completed no later than 2017.

The last 111 metagroups provide for tariff elimination over five years (8 to 19 years depending on the group). Some metagroups also include a protectionist regime, which is provisional in most cases (see table 1). This regime consists of tariff quotas: there is a limited volume of duty-free imports, and imports in excess of that volume are subject to a tariff. Nonetheless, irrespective of its base level (that is, its level when the FTA entered into force), the tariff in question should be phased out over a period of 10 to 19 years (see table 2), according to the tariff reduction categories mentioned above. Moreover, the duty-free quota increases each year —between 3% and 10% (see Appendix I of the FTA)— until the quota disappears altogether in the year in which the products in question become duty-free. This protectionist regime must therefore be seen as provisional and does not call into question the principle of total liberalization of trade in agricultural products between the two countries.

There is an exception in 19 of the 111 metagroups, namely sugar and its derivatives (including sugar confectionery). In this case, cancellation of the tariff quota applied by the United States in the future is not envisaged. Although the quota increases by 750 metric tons annually (with 50,000 tons as the initial quota in 2012), the United States may impose in-quota tariffs at any time, provided that Colombian exporters receive compensation equivalent to the profits they could have obtained in the absence of any restriction (Article 2.19). Nonetheless, the FTA does not specify who will calculate such compensation, or how it will be calculated, or the value of the applied tariff. Moreover, in maintaining this quota, the out-of-quota tariffs are not phased out, but are set at the most favoured nation level (MFN), which rose to 55% in 2015 (WTO, 2015, p. 74).

Table 1
Free trade agreement between Colombia and United States: structure of tariff elimination
by agricultural product metagroups

| Colombia | United States | Quantity | |
|----------------------|---------------------|------------|--------------|
| A (or AA) | | 644 | 75% |
| A + B, or B only | A/F | 102 | 11.9% |
| A | A/F + B | 2 | 0.2% |
| Subtotal 1 | | 748 | 87.1% |
| L, M, C, V or N | A/F | 21 | 2.4% |
| A + R2P, or R2P only | | 22 | 2.6% |
| | A/F + C, or A/F + D | 9 | 1% |
| A | A + R2P/RP | 15 | 1.7% |
| Mixed | Mixed | 44 | 5.2% |
| Subtotal 2 | | 111 | 12.9% |
| | Total | 859 | 100% |

Source: Prepared by the authors, on the basis of the tariff reduction lists.

Note: A metagroup consists of one or more groups of Colombian products and one or more equivalent groups of United States products. The tariff elimination periods are as follows: "A" or "AA" immediate; "B" five years; "L" eight years; "M" nine years; "C" / "V" 10 years; "N" 12 years; and "D" 15 years. "R2P" means the application of a provisional protectionist regime in the metagroup for the country in question. "RP" means the application of a protectionist regime that is not provisional. "Mixed" means that both countries apply a tariff elimination process over more than five years (with a single exception in which a three-year period applies) and a protectionist regime (which is not necessarily provisional in the case of the United States).

Table 2
Free trade agreement between Colombia and United States: agricultural products protected
by provisional tariff quotas

| Product type (in parentheses: year of elimination of the quota and the corresponding tariffs; "1" = 2012) | |
|---|--|
| Colombia | United States |
| Food for domestic animals (8/9) | - |
| Meat of bovine animals, of standard quality* | Meat of bovine animals * (10) |
| Offal of bovine animals (10) | |
| Crude soybean oil (10) | - |
| Glucose (10) | - |
| Dry beans* (10) | - |
| - | Liquid milk and cream (11) |
| | Ice cream (11) |
| | Butter (11) |
| Maize and sorghum (12) | - |
| Milk in powder and yoghurt (15) | - |
| | Tobacco (15) |
| | Cheese and processed dairy products (15) |
| Birds with finished production cycle* (18) | - |
| Poultry leg quarters* (18) | - |
| Rice* (19) | - |

Source: Prepared by the authors.

Note: Products marked with an asterisk are subject to special safeguards (see section II). All tariff elimination is implemented in equal annual stages (EAS), except in the following cases (Colombia): dry beans, 33% tariff reduction in year 1 of the FTA, then elimination in nine EAS (years 2-10); Chicken hindquarters, the base rate is maintained until year 5 (10), then elimination in 13 (8) EAS in years 6-18 (11-18); Rice, the base rate is maintained until year 6, then elimination in 13 EAS (years 7-19).

Ultimately, the following issues arise in relation to the last 111 meta-groups (see table 1):

- In 21 metagroups (2.4% of the total number), each includes a single Colombian group that benefits from a base tariff elimination period of eight years ("L"), nine years ("M"), 10 years ("C" or "V") or 12 years ("N"). For all United States groups, all tariffs were eliminated in 2012 ("A", "F" or both).

- In 22 metagroups (2.6%), each includes at least one Colombian group that benefits from a provisional protectionist regime (tariff quotas). For Colombian groups that do not benefit from this regime, tariff elimination corresponds to category “A”, while all United States groups belong to categories “A” or “F”.
- In nine metagroups (1%) each includes at least one United States group that benefits from a 10- or 15-year tariff-elimination period (respectively “C” and “D”) to phase out the base rate. If a United States group does not benefit from this regime, its tariff elimination occurred either immediately in 2012 (“A”) or else was already duty-free (“F”). In the Colombian groups, tariff elimination was immediate (“A”).
- In 15 metagroups (1.7%), each includes at least one United States group that benefits from a protectionist regime in the form of tariff quotas. This regime is not provisional for two of these metagroups (sugar and its derivatives, as noted above). If a United States group does not benefit from a protectionist regime, its tariff elimination corresponds to categories “A” or “F”, while all Colombian groups are in category “A”.
- The remaining 44 metagroups (5.2%) are “mixed”, since a protectionist regime is applied to one or more groups in both countries or a tariff elimination period longer than five years is granted, or both.³ Some of these metagroups also contain groups comprising sugar and its derivatives, resulting in a non-provisional protectionist regime in the case of the United States.

A “safeguard measure” may also be applied to some Colombian groups that already benefit from a provisional protectionist regime (product type identified by an asterisk in table 2). This measure entails applying an additional tariff if the quantity imported exceeds a certain value (see Annex 2.18 of the FTA for the methods of calculating the additional tariff). Depending on the product, this value varies between 120% and 140% of the corresponding quota. Nonetheless, the safeguard measure should disappear when the quota itself disappears. Here again, the safeguard does not call into question the principle of complete tariff elimination.

In general, agricultural products of Colombian origin have, and will increasingly have, access to the United States market over the next few years. An increase in exports of these products can therefore be expected, which would boost total production and employment. Nonetheless, the United States also has access to the Colombian market, and increasingly so, which means Colombia will need to be as competitive as possible to prevent its agricultural production declining in the face of cheaper or better-quality United States imports. For this reason, a study is made of the competitiveness of Colombian agricultural products relative to those of the United States, through the measure of revealed comparative advantages.

III. Revealed comparative advantage index

The factors that determine the competitiveness of a product or group of products are multidimensional. There are price determinants of competitiveness, in other words, when country A can sell the production of a group at a lower price than country B. The exchange rate is the first factor generating that price difference; other factors relate to the capacity to produce at lower relative costs —wages, intermediate consumption prices, production techniques, transport and marketing costs, taxes and financial costs, among others. There are also determinants of competitiveness that are not linked to prices, such as when the production of country A differs from that of country B in terms of quality, innovations, branding or after-sales service, among other factors (Porter, 1991; Chevassus-Lozza and Gallezot, 1995; Eaton and Kortum, 2002; Costinot, 2009; Chor, 2010; Cuñat and Melitz, 2012).

³ There is one exception, which involves tariff elimination over a three-year period (category “H”, applied to the group comprising natural components of milk not specified or included in another group).

As it is difficult to form a comprehensive view of all the pre-trade factors that determine competitiveness, it is complicated to obtain a single value, based on those factors, that summarizes the competitiveness of a product (or group of products) in one or more countries (Ballance, 1988). The revealed comparative advantage index (RCA) aims to provide a synthetic measure of the ability to produce at lower relative cost by analysing trade, based on the assumption that trade flows (post-trade variables) indirectly reflect these comparative advantages (Balassa, 1977; Lafay, 1987). The RCA index is not intended to identify the determinants of comparative advantage, but to establish the extent to which they exist. The calculation of the RCA index can be understood as a first stage of competitiveness analysis. In the second stage, the main factors explaining the level of comparative advantage achieved by the index should be identified. Although the current study focuses on the first stage, some preliminary observations are also made with respect to the second.

The RCA index is calculated according to a nomenclature of $K \in \mathbb{N} \setminus \{0; 1\}$ products, or product groups, traded in a specific trade zone consisting of $n \in \mathbb{N} \setminus \{0; 1\}$ countries in a time period of $T \in \mathbb{N}^*$ years (or quarters). The zone in question may be the world, the members of the World Trade Organization (WTO), or a group of at least two countries. What needs to be remembered is that the index and the variables that enable its calculation refer only to the selected zone. A country belonging to the zone is identified by the letter i , a group of products by the letter k and a time period by the letter t . The variable RCA_{kit} denotes the RCA index of country i with respect to the product (or group of products) k in period t (and within the zone).

To highlight the contributions of the CEPIL method, the starting point is the index initially proposed by Balassa (1965). $X_{kit} \in \mathbb{R}_+$ represents exports of k (in monetary units) made by country i in time-period t :

$$RCA_{kit} = \left(X_{kit} / \sum_{k=1}^K X_{kit} \right) / \left(\sum_{i=1}^n X_{kit} / \sum_{k=1}^K \sum_{i=1}^n X_{kit} \right) \in \mathbb{R}_+ \quad (1)$$

This index is based on the relative export structure, from which three terms are extracted:

- $\sum_{k=1}^K X_{kit}$ denotes total exports by country i in time t , for the K product groups considered in the nomenclature;
- $\sum_{i=1}^n X_{kit}$ denotes exports of K made in time t by the n countries of the zone;
- $\sum_{k=1}^K \sum_{i=1}^n X_{kit}$ denotes “global” exports in time t , in other words the total exports of the n countries of the zone in that period.

Balassa (1965) compares two shares: in the numerator, the share of exports of k in total exports by country i in time t ; in the denominator, the same share in the n countries of the zone in question. If $RCA_{kit} > 1$, then country i specializes in the production of k in time t , thereby revealing the existence of comparative advantages; and vice versa, if $RCA_{kit} < 1$, i has no specialization in k (in t), thereby revealing disadvantages.

Nonetheless, the Balassa (1965) indicator does not really allow comparative advantage (or specialization) to be determined, but instead makes a comparison between the structure of a country's exports and the structure of exports from the area as a whole over a given period (Balassa, 1977), thereby only establishing export potential (Balassa, 1977; Raghurampatruni, 2012; Aytaç and Kiliç, 2014). This is explained by the absence of imports. In fact, by defining $M_{kit} \in \mathbb{R}^+$ as imports of k made by country i in time t , the trade patterns can show that:

$$m_{kit} > x_{kit} \exists (k; i; t), \text{ where:}$$

$$\begin{aligned}
 x_{kit} &:= \left(X_{kit} / \sum_{k=1}^K X_{kit} \right) / \left(\sum_{i=1}^n X_{kit} / \sum_{k=1}^K \sum_{i=1}^n X_{kit} \right) \\
 m_{kit} &:= \left(M_{kit} / \sum_{k=1}^K M_{kit} \right) / \left(\sum_{i=1}^n M_{kit} / \sum_{k=1}^K \sum_{i=1}^n M_{kit} \right)
 \end{aligned}
 \tag{2}$$

In this case, i displays a greater propensity to export k (in time period t) than the zone as a whole; but, at the same time, i shows an even greater propensity to import k (in t). For this reason, there would be intra-industry trade (trade in different varieties of the same product, Krugman, 1995) which limits the specialization of i and its comparative advantages for k (Lafay, 1990).

To avoid the shortcomings of (1), Balassa (1966) proposes another indicator, which includes imports:

$$RCA_{kit} := \frac{X_{kit} - M_{kit}}{X_{kit} + M_{kit}} \in [-1; 1]
 \tag{3}$$

With the indicator specified in this way, if country i records a positive trade balance (numerator) for k in time t , it is assumed that i specializes in the production of k in t and thus has comparative advantages, which is reflected in $RCA_{kit} > 0$. Conversely, if $RCA_{kit} < 0$, then country i does not specialize and reveals disadvantages. Also, $RCA_{kit} = 0$ denotes the absence of (dis)advantages. Thus:

- Specialization is more intense, and the advantages are greater, if the positive trade balance of k recorded by i in t is a larger proportion of the volume of trade in k by country i in period t (denominator), which is reflected in $RCA_{kit} \rightarrow 1$.
- In the case of disadvantages (non-specialization), these are more important if the trade deficit of k recorded by country i in t has a greater weight in country i 's trade in k in time t (denominator), which is reflected in $RCA_{kit} \rightarrow -1$.

Another alternative is the RCA index in terms of contribution to the trade balance (Lafay, 1987), which precedes the CEPII indicator:

$$RCA_{kit} := \frac{1}{\sum_{k=1}^K W_{kit}} \left[X_{kit} - M_{kit} - u_{kit} \sum_{i=1}^n (X_{kit} - M_{kit}) \right] \in \mathbb{R} \text{ where:}
 \tag{4}$$

$$u_{kit} := \frac{W_{kit}}{\sum_{k=1}^K W_{kit}}$$

$$W_{kit} := X_{kit} + M_{kit}$$

This RCA index is calculated in two stages:

- First, the difference between the trade balance of k recorded by i in t and a theoretical balance defined as $u_{kit} \sum_{i=1}^n (X_{kit} - M_{kit})$, is calculated; in other words, the total trade balance recorded by i in t , weighted by the coefficient u_{kit} . This is the ratio of W_{kit} to $\sum_{k=1}^K W_{kit}$, or the share of k in country i 's trade in t relative to total trade by that country in the same period. If the balance is higher than its theoretical level, there is a positive difference and hence $RCA_{kit} > 0$, so it is assumed that i displays comparative advantages with respect to k in period t , and vice-versa if it is lower. If $RCA_{kit} = 0$, there are no advantages or disadvantages.

- Second, the difference between the trade balance $X_{kit} - M_{kit}$ and its theoretical level $u_{kit} \sum_{i=1}^n (X_{kit} - M_{kit})$ is divided by $\sum_{k=1}^K W_{kit}$, which represents country i 's total trade in time period t . Thus:
 - When the difference between $X_{kit} - M_{kit}$ and $u_{kit} \sum_{i=1}^n (X_{kit} - M_{kit})$ is positive, the revealed advantages are less important if i 's total trade in period t is higher.
 - When the difference between $X_{kit} - M_{kit}$ and $u_{kit} \sum_{i=1}^n (X_{kit} - M_{kit})$ is negative, the revealed disadvantages are less important if i 's total trade in period t is higher.
 - When $X_{kit} - M_{kit} - u_{kit} \sum_{i=1}^n (X_{kit} - M_{kit}) = 0$ then $RCA_{kit} = 0$: the absence of (dis) advantages persists irrespective of country i 's total trade in t .

Nonetheless, despite taking both exports and imports into account, the foregoing indicators (3 and 4) have two weaknesses. First, they do not consider the size of national production. For two different countries, i and j , obtaining $RCA_{kit} = RCA_{kjt}$ using these indicators should not mean that both display the same level of (dis)advantages:

- If $RCA_{kit} = RCA_{kjt} > 0$ and if i produces less than j , then i has a higher level of specialization, so country i 's advantage must be greater than j 's, rather than identical.
- If $RCA_{kit} = RCA_{kjt} < 0$ and if i produces less than j , then i has a lower level of specialization, so country i 's disadvantage must be greater than j 's, rather than identical.

Second, neither indicator considers the immediate economic situation surrounding trade. The idea is to reveal comparative (dis)advantages, in other words the structural factors that contribute to competitiveness. However, trade may reflect short-term fluctuations, which by definition should not be used to reveal structural factors. From this standpoint, ignoring the bias introduced by short-term fluctuations when calculating the RCA index can lead to unfounded advantages or disadvantages.

CEPII proposes an indicator of contribution to the trade balance, which, unlike (4), takes account of gross domestic product (GDP) and also corrects the "short-term" bias in trade.⁴ The indicator not only makes it possible to compare trade in several product groups by several countries, over several periods and on a common basis, but also to correct a number of distortions (Danna-Buitrago and Stellan, 2014). As this is the most complete RCA index since that formulated by Balassa (1965), we chose to use it in the present study. The indicator is calculated according to the following system:

$$RCA_{kit} := \frac{1000}{Y_{it}} \left[X'_{kit} - M'_{kit} - v_{kt} \sum_{k=1}^K (X'_{kit} - M'_{kit}) \right] \in \mathbb{R}$$

where:

Y_{it} is the GDP of country i in time t

$$v_{kt} := W_{kt} / W_t \tag{5}$$

$$W_{kt} := \sum_{i=1}^n (X_{kit} + M_{kit}) ; W_t := \sum_{k=1}^K W_{kt}$$

$$X'_{kit} := X_{kit} \cdot e_{kt} ; M'_{kit} := M_{kit} \cdot e_{kt}$$

$$e_{kt} := 1 \text{ si } W_{kt} / W_t = 0 ; \text{ otherwise } e_{kt} := \frac{W_{kr} / W_r}{W_{kt} / W_t}$$

⁴ The evolution of the indicators proposed by CEPII before producing this latest version can be consulted in Lafay (1987, 1990 and 1992), De Saint Vaulry (2008) and the CEPII website [online] www.cepii.fr/%5C/anglaisgraph/bdd/chelem/indicators/indicspeit.htm.

Unlike equation (4):

- Equation (5) does not contain the k trade balance $X_{kit} - M_{kit}$; but instead $X'_{kit} - M'_{kit}$ resulting from the adjustment of X_{kit} and M_{kit} by a coefficient e_{kt} , the role of which is explained below. Moreover, the total trade balance $\sum_{i=1}^n (X_{kit} - M_{kit})$ is replaced by the adjusted total balance $\sum_{k=1}^K (X'_{kit} - M'_{kit})$.
- The (adjusted) total trade balance is not weighted by the share of k in the country's total trade over the same period (u_{kit}). Instead, it is weighted by the share of trade in k by the n countries of the zone in time t relative to the total trade of the same countries in the same period (v_{kt}).
- The difference between the (adjusted) balance and its theoretical level is not divided by $\sum_{k=1}^K W_{kit}$ but by Y_{it} . Thus, where two countries report the same difference, the country with the lowest GDP has greater advantages or less disadvantages. Multiplying the result by 1,000 makes it possible to express RCA_{kit} in thousandths of the GDP of country i in time-period t (%o).

To understand the adjustment of X_{kit} and M_{kit} by e_{kt} , the starting point is W_{kt} , which represents trade in k by all the countries in the zone in period t . Once W_{kt} has been calculated for each k , it is possible to sum $W_{1t} + W_{2t} + \dots + W_{Kt}$ and thus calculate W_t , which represents "global" trade defined as the trade in all K product groups in t by all countries in the zone. The coefficient e_{kt} is determined by selecting a "reference period" denoted by the letter r . Thus, W_{kr}/W_r is the share of k in global trade in the reference period r . It is assumed that W_{kr}/W_r reflects the structural factors of k trade irrespective of short-term fluctuations. From this standpoint:

- If $e_{kt} = 1$ then $W_{kr}/W_r = W_{kt}/W_t$. This means that the share of k in global trade in time-period t is equal to the equivalent share in period r . In other words, $e_{kt} = 1$ assumes that X_{kit} and M_{kit} do not reflect biases due to short-term fluctuations, since k has the same importance in global trade in both periods, r and t . No adjustment is required, since multiplying X_{kit} and M_{kit} by $e_{kt} = 1$ gives $X'_{kit} = X_{kit}$ and $M'_{kit} = M_{kit}$.
- If $W_{kt}/W_t = 0$, then e_{kt} cannot be calculated, since division by 0 is undefined. In this case, there are no exports or imports of k in period t . Thus, it is assumed that the adjusted exports and imports will also be equal to 0. So, if $W_{kt}/W_t = 0$ we write $e_{kt} = 1$, which implies $X'_{kit} = X_{kit} = M'_{kit} = M_{kit} = 0$.
- If, in contrast, $W_{kt}/W_t \neq W_{kr}/W_r$ with $W_{kt}/W_t \neq 0$, it is assumed that X_{kit} and M_{kit} reflect short-term fluctuations in addition to structural factors. For example, if $e_{kt} = 1.25$, it means that the share of k in global trade in the reference period r is logically $1.25 - 1 = 0.25$, in other words 25% higher than the equivalent share in period t . Thus, X_{kit} and M_{kit} should be 25% higher to correspond to W_{kr}/W_r , that is, to correspond to the structural part of trade in k rather than W_{kt}/W_t . Thus, X_{kit} and M_{kit} must be 25% larger, or multiplied by 1.25, a coefficient that precisely represents the value of e_{kt} .

Ultimately, after adjusting exports and imports, if the value of the indicator changes from one period to another, this is assumed to exclusively reflect variations in structural factors (for example, productivity) in one country or another. Likewise, after calculating X'_{kit} for each k and for each t , it is possible to sum $X'_{i1t} + X'_{i2t} + \dots + X'_{iKt}$ to obtain the adjusted total exports of country i in period t , denoted by X'_{it} , and the same applies to the adjusted total imports of i in t , denoted by M'_{it} .

Lastly, the results of the RCA index calculated according to equation (5) are interpreted in the same way as those of equation (4). $RCA_{kit} > 0$ is equivalent to having comparative advantages for i with respect to k in period t ; and these advantages are greater or have more influence when the value

of the indicator is higher (more positive). $RCA_{kit} < 0$ implies comparative disadvantages for i with respect to k in period t ; and these disadvantages are greater or have more influence when the value of the indicator is smaller (more negative). $RCA_{kit} = 0$ indicates the absence of (dis)advantages.

IV. Parameter setting and analysis

As this study seeks to identify Colombia's comparative (dis)advantages in the bilateral trade zone with the United States, country i is Colombia and $n = 2$. Data for exports and imports are taken from UNCTADstat (unctadstat.unctad.org), supplied according to the three-digit SITC Rev.3 nomenclature.⁵ Thus, RCA_{kit} is calculated from the trade of $K = 255$ product groups k .⁶ It will then be possible to focus on the results of the 60 groups comprising exclusively agricultural products, including the following⁷ (see annex A1):

- 36 groups, with codes beginning with 0, consisting of live animals and crude or processed foodstuffs (other than waters, alcoholic beverages and edible oils).
- 4 groups with codes starting with 1, consisting of mineral waters and soft drinks (code 111), alcoholic beverages (112), tobacco (121) and their derivatives (122).
- 16 groups, with codes beginning with 2, composed of crude inedible materials of animal or vegetable origin (except oils).
- 4 groups, with codes beginning with 4, composed of oils of animal or vegetable origin.

The GDP data, Y_{it} for each (i, t) , are taken from the World Bank (datos.bancomundial.org), and they are converted from current dollars to thousands of current dollars in order to express them in the same unit as X_{kit} and M_{kit} . UNCTADstat provides annual data from 1995 to 2014. It is therefore possible to calculate RCA_{kit} over two decades, so $t \in \{1995; 1996; \dots; 2014\}$ and $T = 20$. This is done to identify a trend in the behavior of the RCA index over time, and thus analyse comparative (dis)advantages from a dynamic vantage point. In fact, calculating a single-year RCA index, or that of the three years available since the implementation of the FTA (2012, 2013 and 2014), does not identify the trend of the indicator over time. Lastly, the reference period r that corrects the short-term bias will be 2014. The last available year is chosen with a retrospective or “backward-looking” approach, assuming that 2014 reflects the structural trends of trade and excludes the bias generated by short-term fluctuations, which makes it possible to adjust X_{kit} and M_{kit} from the previous years.⁸

To analyze the results, six categories K_1, K_2, \dots, K_6 are created to identify a time-trend in the behavior of the RCA index for each k product group (Danna-Buitrago and Stellan, 2014). Thus, depending on the vector $(VCR_{ki1995}; VCR_{ki1996}; \dots; VCR_{ki2014}) \in \mathbb{R}^{20}$, k belongs to one category ($k \in K_x \exists x \in \{1; 2; \dots; 6\}$) and not to the others ($k \in K_x \Rightarrow k \notin K_y \forall x, y \in \{1; 2; \dots; 6\}, y \neq x$). From one category to another, that is, from K_x to K_{x+1} , k displays increasingly fewer comparative advantages

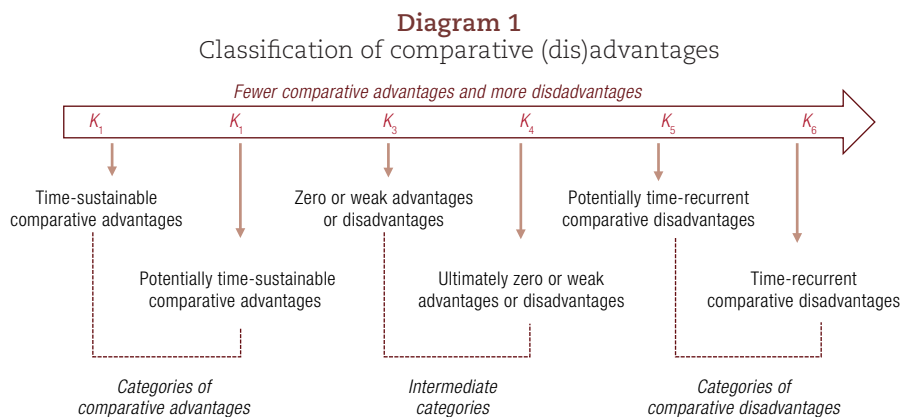
⁵ See [online] <http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=14&Top=2&Lg=2>.

⁶ The calculations ignore services, because the databases consulted (UN Service Trade, WTO, Organization for Economic Cooperation and Development (OECD) and International Monetary Fund (IMF)) do not produce statistics that are sufficiently granular to identify this trade between Colombia and the United States. According to UN Service Trade, services accounted for roughly 15.47% of trade between Colombia and the rest of the world between 1995 and 2013. Assuming the same trend is observed in the trade between the two partners, it can be said that roughly 85% of the trade between them was used to calculate the comparative advantages of Colombia with respect to the United States

⁷ Working with the three-digit SITC nomenclature is a solution to the lack of uniformity in the FTA product lists, as shown in Section II (four lists without uniform coding). It also allows comparative advantages to be calculated at a more aggregate level than the 859 FTA metagroups, thereby affording an overview of these advantages. Future research could go into greater detail using a more granular nomenclature.

⁸ In contrast, a prospective or “forward-looking” approach is based on the first available period.

and more disadvantages (see diagram 1). The categories are constructed according to a parameter $\varepsilon \in \mathbb{R}^+$. If $VCR_{kit} > +\varepsilon$, it is assumed that the indicator is “sufficiently” different from 0 to claim that the comparative advantages are significant. If $VCR_{kit} > -\varepsilon$, the same can be assumed with respect to the disadvantages. If $-\varepsilon \leq VCR_{kit} \leq +\varepsilon$ it is assumed that the indicator is not “sufficiently” far from 0, thereby displaying no (dis)advantage or weak (dis)advantages.



Source: Prepared by the authors.

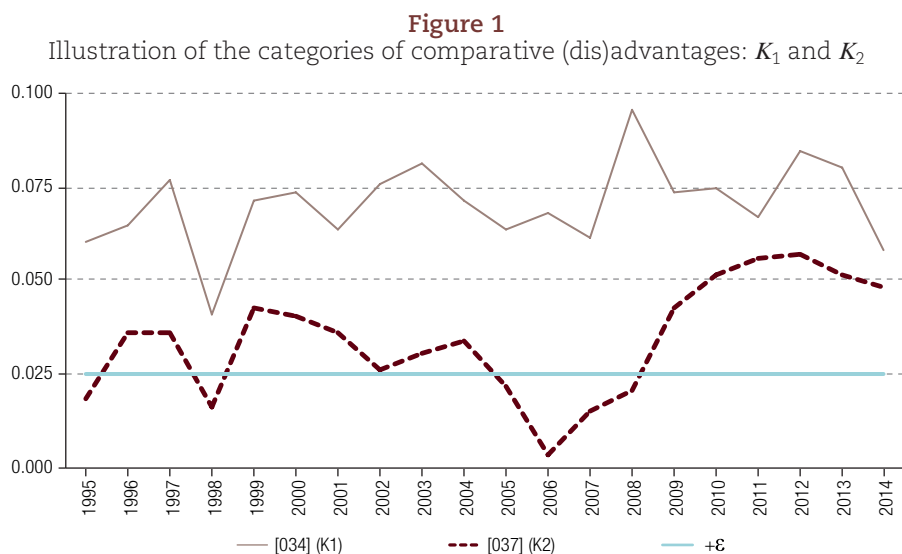
The first two categories are as follows:

- K_1 comprises groups that show sustainable comparative advantages over time. $k \in K_1$ if, for each t , its RCA index is higher than the $+\varepsilon$ level, showing significant advantages that recur periodically (see figure 1). Thus:

$$K_1 := \{k: RCA_{kit} > +\varepsilon \forall t\}$$

- K_2 comprises groups that have not shown time-sustainable comparative advantages, unlike K_1 , but have the potential for them. $k \in K_2$ if its RCA index has not always been greater than $+\varepsilon$, but ends the last period above this level (see figure 1). Thus:

$$K_2 := \{k: RCA_{kit} \leq +\varepsilon \exists t \neq T; \lim_{t \rightarrow T} RCA_{kit} > +\varepsilon\}$$



Source: Prepared by the authors.

The following two categories are referred to as “intermediate”:

- K_3 comprises groups that are “neutral” with respect to the (dis)advantages. $k \in K_3$ if, for each t , its RCA index is within the interval $[-\varepsilon; +\varepsilon]$, so the (dis)advantages are considered weak from one period to another (see figure 2). Thus:

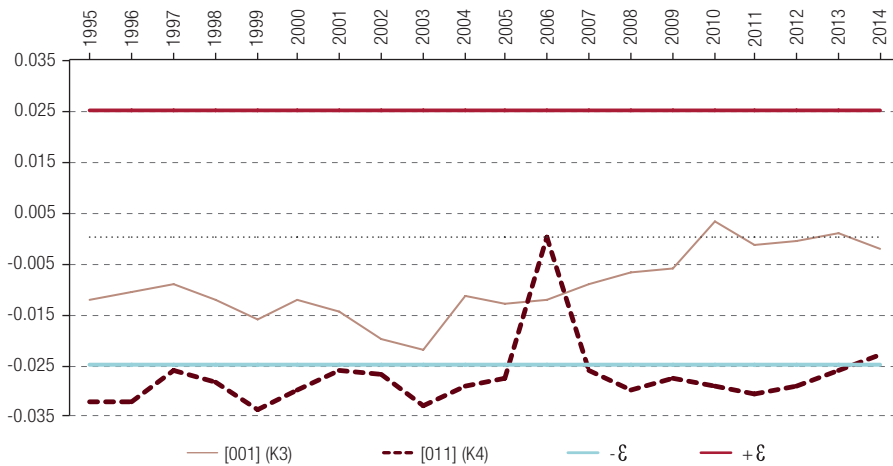
$$K_3 := \{k: RCA_{kit} \in [-\varepsilon; +\varepsilon] \forall t\}$$

- K_4 comprises groups that are “neutral *in fine*” with respect to the (dis)advantages. $k \in K_4$ if its RCA index has not always been in $[-\varepsilon; +\varepsilon]$ but ends in that range (see figure 2). Thus:

$$K_4 := \{k: RCA_{kit} \notin [-\varepsilon; +\varepsilon] \exists t \neq T; \lim_{t \rightarrow T} RCA_{kit} \in [-\varepsilon; +\varepsilon]\}$$

Figure 2

Illustration of the categories of comparative (dis)advantages: K_3 and K_4



Source: Prepared by the authors.

The last two categories are the “negative counterparts” of K_1 and K_2 :

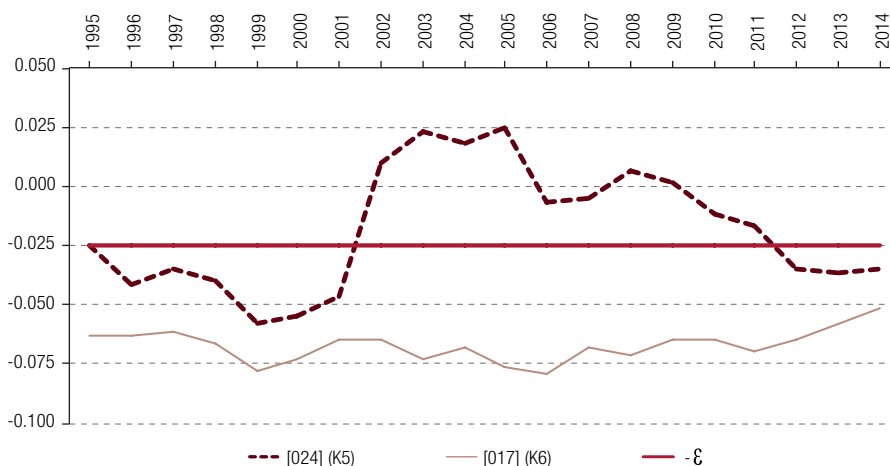
- K_5 comprises groups that do not show recurrent comparative disadvantages over time but have the potential to do so. $k \in K_5$ if its RCA index has not always been below a $-\varepsilon$, but ends the final period below this level (see figure 3). Thus:

$$K_5 := \{k: RCA_{kit} \geq -\varepsilon \exists t \neq T; \lim_{t \rightarrow T} RCA_{kit} < -\varepsilon\}$$

- K_6 comprises groups which show recurrent comparative disadvantages. $k \in K_6$ if, for each t , its RCA index is below the $-\varepsilon$ level showing significant disadvantages that recur periodically (see figure 3). Thus:

$$K_6 := \{k: RCA_{kit} < -\varepsilon \forall t\}$$

Figure 3
Illustration of the categories of comparative (dis)advantages: K_5 and K_6



Source: Prepared by the authors.

In this study, 0.025 is set as the value of ε used to distribute the 60 groups among the six categories mentioned. This value is a starting point, which can certainly be changed in future research to determine the extent to which the content of the categories changes as ε is varied. In fact, it can be shown that $\exists E \in \mathbf{R}^+ : \varepsilon \geq E \Rightarrow K_1 = \emptyset$ in other words, a sufficiently high value of ε means that no group displays time-sustainable comparative advantages, and, vice-versa, $\varepsilon = 0 \Rightarrow \max \#K_1$ that is, the minimum value of ε results in the maximum number of groups with comparative advantages that are sustainable over time. In this study, this maximum is 6. So a “pessimistic” view is adopted if ε is set sufficiently large (no group would belong to K_1), whereas an “optimistic” point of view is adopted if ε is set to its minimum level (six groups would belong to K_1). In this case, an “intermediate” view was adopted, with $\varepsilon = 0,025$, since this value results in three groups in K_1 , or exactly the middle range, defined as halfway between the minimum (0) and the maximum (6). It can also be shown that any value of ε between 0.02375 and 0.04025 approximately results in the middle range; and, in fact, $\varepsilon = 0,025$ is within that range.

V. Results and analysis

Based on the parameters described above, tables 3 and 4 report the RCA indexes obtained for the 60 groups of agricultural products and their derivatives.

Table 5 shows the distribution of the 60 groups among the six categories, according to the indicators obtained. In addition to three groups that belong to K_1 and, consequently, have the ability to compete against the United States, in K_2 there are four groups with the potential for that ability. Thus, the FTA is of interest to seven of the 60 groups analyzed. Nonetheless, that interest really only exists for five of the seven groups in question. In table 5, the letter “E” accompanying groups [061] and [062] (sugar and its derivatives) indicates that the United States can continue to apply a protectionist regime without it being provisional, contrary to all other regimes of the FTA (see section II). This reduces the opportunities for Colombia to increase the production of sugar and its derivatives by growing its exports to the United States.

Table 3
Colombia and the United States: revealed comparative advantage index (RCA) of selected SITC groups, 1995-2014 (1)

| SITC | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| [001] | -0.012 | -0.010 | -0.009 | -0.013 | -0.016 | -0.013 | -0.014 | -0.020 | -0.022 | -0.012 | -0.013 | -0.012 | -0.009 | -0.007 | -0.006 | 0.003 | -0.001 | -0.000 | 0.001 | -0.002 |
| [011] | -0.032 | -0.032 | -0.026 | -0.029 | -0.034 | -0.030 | -0.026 | -0.027 | -0.033 | -0.029 | -0.028 | 0.000 | -0.026 | -0.030 | -0.027 | -0.029 | -0.031 | -0.029 | -0.026 | -0.023 |
| [012] | -0.459 | -0.459 | -0.441 | -0.471 | -0.561 | -0.528 | -0.475 | -0.457 | -0.499 | -0.418 | -0.476 | -0.497 | -0.449 | -0.508 | -0.451 | -0.456 | -0.469 | -0.443 | -0.414 | -0.367 |
| [016] | -0.009 | -0.009 | -0.007 | -0.009 | -0.011 | -0.008 | -0.008 | -0.007 | -0.008 | -0.007 | -0.008 | -0.006 | -0.006 | -0.005 | -0.006 | -0.007 | -0.008 | -0.007 | -0.007 | -0.006 |
| [017] | -0.063 | -0.063 | -0.061 | -0.066 | -0.078 | -0.072 | -0.064 | -0.065 | -0.073 | -0.067 | -0.076 | -0.079 | -0.068 | -0.071 | -0.064 | -0.065 | -0.070 | -0.065 | -0.058 | -0.051 |
| [022] | -0.099 | -0.097 | -0.097 | -0.103 | -0.116 | -0.104 | -0.092 | -0.066 | -0.020 | -0.032 | -0.065 | -0.067 | -0.065 | -0.100 | -0.077 | -0.083 | -0.105 | -0.104 | -0.097 | -0.083 |
| [023] | 0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | 0.000 | 0.000 | 0.000 | -0.002 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | 0.000 | 0.000 | -0.000 | -0.000 | 0.000 |
| [024] | -0.024 | -0.041 | -0.035 | -0.039 | -0.058 | -0.054 | -0.047 | 0.010 | 0.023 | 0.019 | 0.025 | -0.007 | -0.004 | 0.006 | 0.001 | -0.011 | -0.017 | -0.034 | -0.036 | -0.035 |
| [025] | -0.013 | -0.004 | -0.005 | -0.005 | -0.004 | -0.004 | -0.007 | -0.004 | -0.003 | -0.003 | -0.004 | -0.003 | -0.003 | -0.003 | -0.002 | -0.002 | -0.002 | -0.002 | -0.002 | -0.002 |
| [034] | 0.060 | 0.065 | 0.077 | 0.041 | 0.072 | 0.073 | 0.063 | 0.075 | 0.081 | 0.071 | 0.063 | 0.068 | 0.062 | 0.096 | 0.074 | 0.075 | 0.067 | 0.085 | 0.081 | 0.058 |
| [035] | -0.001 | -0.001 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | 0.000 | -0.000 | -0.000 | 0.000 | 0.000 | 0.000 | -0.000 | 0.000 | 0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| [036] | -0.089 | -0.061 | -0.039 | -0.051 | -0.083 | -0.075 | -0.087 | -0.083 | -0.062 | -0.039 | -0.025 | -0.013 | 0.006 | 0.010 | 0.010 | 0.010 | 0.012 | 0.010 | 0.009 | 0.012 |
| [037] | 0.018 | 0.036 | 0.036 | 0.016 | 0.043 | 0.040 | 0.036 | 0.026 | 0.031 | 0.034 | 0.022 | 0.004 | 0.016 | 0.021 | 0.043 | 0.051 | 0.055 | 0.057 | 0.052 | 0.048 |
| [041] | -0.693 | -0.663 | -0.572 | -0.644 | -0.896 | -0.773 | -0.712 | -0.810 | -0.922 | -0.829 | -0.785 | -0.735 | -0.754 | -0.759 | -0.601 | -0.588 | -0.635 | -0.582 | -0.505 | -0.464 |
| [042] | -0.178 | -0.194 | -0.187 | -0.325 | -0.217 | -0.206 | -0.190 | -0.176 | -0.208 | -0.187 | -0.195 | -0.204 | -0.183 | -0.210 | -0.198 | -0.201 | -0.214 | -0.196 | -0.173 | -0.158 |
| [043] | -0.036 | 0.000 | 0.000 | -0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | -0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| [044] | -2.546 | -2.703 | -2.495 | -2.605 | -3.281 | -3.101 | -2.783 | -2.900 | -3.238 | -3.081 | -2.936 | -3.253 | -2.947 | -3.040 | -2.576 | -2.651 | -2.832 | -2.687 | -2.516 | -2.081 |
| [045] | -0.002 | -0.003 | -0.001 | -0.001 | -0.002 | -0.002 | -0.004 | -0.003 | -0.003 | -0.002 | -0.002 | -0.002 | -0.002 | -0.004 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 |
| [046] | -0.001 | -0.002 | -0.001 | -0.001 | -0.002 | -0.001 | -0.002 | -0.002 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| [047] | -0.013 | 0.011 | -0.009 | -0.004 | -0.004 | 0.012 | -0.012 | -0.010 | -0.001 | -0.003 | 0.004 | 0.003 | -0.004 | 0.002 | 0.004 | 0.009 | 0.010 | 0.012 | 0.008 | 0.003 |
| [048] | -0.037 | -0.034 | -0.049 | -0.032 | -0.004 | 0.002 | -0.000 | 0.026 | 0.010 | 0.035 | 0.047 | 0.050 | 0.047 | 0.061 | 0.021 | 0.066 | 0.052 | 0.033 | 0.025 | -0.009 |
| [054] | -0.023 | 0.006 | -0.017 | -0.019 | -0.020 | -0.028 | -0.003 | -0.002 | 0.019 | 0.005 | 0.013 | 0.009 | -0.012 | -0.021 | -0.015 | -0.022 | -0.035 | -0.019 | -0.016 | -0.024 |
| [056] | 0.004 | -0.009 | -0.031 | -0.047 | -0.021 | -0.001 | 0.008 | 0.011 | 0.029 | 0.016 | 0.004 | -0.030 | -0.028 | -0.039 | -0.032 | -0.022 | -0.028 | -0.040 | -0.045 | -0.044 |
| [057] | 0.211 | 0.339 | 0.351 | 0.225 | 0.023 | 0.128 | 0.087 | 0.032 | 0.141 | 0.211 | 0.219 | 0.254 | 0.318 | 0.492 | 0.432 | 0.534 | 0.486 | 0.510 | 0.497 | 0.344 |
| [058] | -0.028 | -0.039 | -0.009 | -0.002 | 0.032 | 0.033 | 0.051 | 0.060 | 0.053 | 0.055 | 0.058 | 0.061 | 0.061 | 0.070 | 0.069 | 0.066 | 0.069 | 0.050 | 0.043 | 0.017 |
| [059] | 0.003 | -0.004 | -0.022 | -0.029 | -0.034 | -0.022 | -0.009 | -0.018 | -0.002 | 0.006 | 0.004 | 0.003 | 0.004 | 0.008 | 0.016 | 0.014 | -0.012 | -0.028 | -0.023 | -0.023 |
| [061] | 0.019 | 0.011 | 0.041 | -0.030 | -0.024 | 0.023 | -0.010 | -0.032 | -0.027 | 0.006 | 0.007 | -0.013 | -0.047 | 0.003 | 0.056 | 0.083 | 0.072 | 0.079 | 0.054 | 0.046 |
| [062] | 0.001 | 0.003 | 0.018 | -0.023 | 0.029 | 0.043 | 0.033 | 0.035 | 0.027 | 0.017 | 0.031 | 0.033 | 0.024 | 0.045 | 0.049 | 0.081 | 0.081 | 0.073 | 0.076 | 0.063 |
| [071] | 1.311 | 1.583 | 1.414 | 0.968 | 1.202 | 1.433 | 1.375 | 1.270 | 1.506 | 1.404 | 1.277 | 1.469 | 1.453 | 2.115 | 1.995 | 2.356 | 2.454 | 2.496 | 2.533 | 2.352 |
| [072] | -0.002 | 0.002 | 0.001 | 0.002 | -0.006 | 0.007 | 0.000 | -0.004 | -0.002 | -0.004 | 0.001 | 0.006 | 0.006 | 0.008 | 0.009 | 0.005 | 0.013 | 0.013 | 0.014 | 0.012 |

Source: Prepared by the authors. For the content of each SITC group, see annex A1.

Table 4
Colombia and the United States: revealed comparative advantage index (RCA) of selected SITC groups, 1995-2014 (2)

| SITC | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| [073] | -0.049 | -0.059 | -0.032 | -0.041 | -0.052 | -0.035 | -0.048 | -0.062 | -0.059 | -0.065 | -0.043 | -0.039 | -0.050 | -0.056 | -0.043 | -0.021 | -0.036 | -0.039 | -0.032 | -0.034 |
| [074] | -0.019 | -0.021 | -0.020 | -0.020 | -0.025 | -0.023 | -0.018 | -0.020 | -0.024 | -0.026 | -0.023 | -0.030 | -0.025 | -0.025 | -0.022 | -0.021 | -0.024 | -0.021 | -0.017 | -0.017 |
| [075] | 0.013 | 0.011 | 0.016 | 0.011 | 0.019 | 0.015 | 0.013 | 0.012 | 0.016 | 0.015 | 0.017 | 0.016 | 0.012 | 0.019 | 0.020 | 0.023 | 0.023 | 0.023 | 0.023 | 0.018 |
| [081] | -0.793 | -0.840 | -0.790 | -0.845 | -0.948 | -0.904 | -0.844 | -0.837 | -0.936 | -0.874 | -0.880 | -0.960 | -0.854 | -0.917 | -0.778 | -0.786 | -0.848 | -0.786 | -0.688 | -0.625 |
| [091] | -0.007 | -0.008 | -0.007 | -0.007 | -0.021 | -0.005 | -0.004 | -0.001 | -0.002 | 0.001 | 0.000 | -0.003 | 0.003 | 0.004 | 0.003 | 0.002 | -0.002 | -0.005 | -0.004 | -0.004 |
| [098] | -0.361 | -0.387 | -0.357 | -0.399 | -0.450 | -0.373 | -0.298 | -0.380 | -0.365 | -0.299 | -0.131 | -0.286 | -0.167 | -0.203 | -0.230 | -0.188 | -0.239 | -0.221 | -0.275 | -0.276 |
| [111] | -0.031 | 0.012 | -0.047 | -0.029 | 0.038 | 0.025 | 0.025 | 0.036 | 0.040 | 0.044 | 0.044 | 0.046 | 0.041 | 0.046 | 0.031 | 0.033 | 0.025 | 0.005 | -0.011 | -0.023 |
| [112] | -0.011 | -0.008 | -0.010 | -0.014 | -0.015 | -0.004 | 0.000 | -0.001 | 0.024 | 0.011 | 0.012 | -0.002 | -0.017 | 0.001 | -0.006 | -0.006 | -0.014 | -0.024 | -0.016 | -0.023 |
| [121] | -0.002 | -0.003 | -0.001 | -0.005 | -0.002 | -0.001 | -0.002 | -0.003 | -0.006 | -0.006 | 0.000 | -0.000 | -0.001 | 0.002 | 0.001 | 0.001 | 0.003 | 0.002 | 0.003 | 0.002 |
| [122] | -0.026 | -0.030 | -0.019 | -0.039 | -0.024 | -0.002 | -0.038 | -0.090 | -0.126 | -0.141 | -0.039 | -0.037 | -0.031 | -0.002 | -0.000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| [211] | -0.009 | -0.007 | -0.010 | 0.000 | -0.001 | -0.001 | -0.000 | -0.000 | -0.002 | 0.000 | -0.000 | 0.001 | -0.000 | -0.003 | -0.003 | 0.002 | -0.003 | -0.001 | -0.002 | -0.002 |
| [212] | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | 0.000 | 0.000 | 0.000 | -0.000 | -0.000 | 0.000 | -0.000 | 0.000 | -0.000 | -0.000 | -0.000 |
| [222] | -0.411 | -0.496 | -0.432 | -0.440 | -0.504 | -0.508 | -0.479 | -0.522 | -0.555 | -0.517 | -0.500 | -0.554 | -0.502 | -0.509 | -0.453 | -0.446 | -0.478 | -0.442 | -0.415 | -0.351 |
| [223] | -0.069 | 0.109 | -0.106 | -0.108 | -0.131 | -0.122 | -0.107 | -0.107 | -0.127 | -0.172 | -0.146 | -0.143 | -0.127 | -0.134 | -0.115 | -0.119 | -0.127 | -0.119 | -0.112 | -0.094 |
| [231] | -0.004 | -0.003 | -0.002 | -0.002 | -0.002 | -0.002 | -0.002 | -0.002 | -0.002 | -0.002 | -0.002 | -0.002 | -0.002 | -0.002 | -0.002 | -0.002 | -0.002 | -0.001 | -0.001 | -0.001 |
| [245] | -0.001 | -0.001 | -0.001 | -0.003 | -0.003 | -0.002 | -0.001 | -0.001 | 0.001 | 0.001 | 0.000 | 0.000 | 0.000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| [246] | -0.000 | -0.000 | -0.000 | -0.000 | -0.001 | -0.000 | 0.000 | -0.000 | -0.000 | 0.000 | -0.000 | 0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| [247] | -0.003 | -0.002 | 0.001 | -0.008 | -0.005 | -0.004 | -0.001 | -0.002 | -0.003 | -0.004 | -0.002 | -0.004 | -0.002 | -0.004 | -0.003 | -0.002 | -0.003 | -0.003 | -0.002 | -0.002 |
| [248] | -0.010 | -0.005 | -0.016 | -0.021 | -0.019 | 0.002 | -0.003 | -0.009 | 0.006 | -0.012 | -0.006 | -0.017 | -0.013 | -0.017 | -0.011 | -0.009 | -0.016 | -0.015 | -0.014 | -0.014 |
| [251] | -0.232 | -0.227 | -0.215 | -0.236 | -0.293 | -0.290 | -0.266 | -0.282 | -0.324 | -0.273 | -0.272 | -0.290 | -0.260 | -0.261 | -0.225 | -0.221 | -0.239 | -0.216 | -0.194 | -0.174 |
| [261] | -0.000 | -0.000 | 0.000 | -0.000 | -0.000 | -0.000 | -0.000 | 0.000 | 0.000 | -0.000 | 0.000 | 0.000 | 0.000 | -0.000 | -0.000 | 0.000 | 0.000 | -0.000 | -0.000 | -0.000 |
| [263] | -0.163 | -0.142 | -0.161 | -0.180 | -0.192 | -0.198 | -0.198 | -0.219 | -0.269 | -0.261 | -0.211 | -0.234 | -0.178 | -0.160 | -0.140 | -0.125 | -0.139 | -0.122 | -0.106 | -0.100 |
| [265] | -0.000 | 0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.001 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| [268] | -0.005 | -0.002 | -0.000 | -0.001 | -0.003 | -0.003 | -0.000 | -0.002 | -0.003 | -0.003 | -0.003 | 0.001 | -0.002 | -0.003 | -0.002 | -0.003 | -0.003 | -0.003 | 0.000 | -0.002 |
| [291] | -0.021 | -0.024 | -0.016 | -0.025 | -0.019 | -0.030 | -0.023 | -0.029 | -0.039 | -0.035 | -0.034 | -0.033 | -0.019 | -0.019 | -0.023 | -0.012 | -0.011 | -0.009 | -0.007 | -0.014 |
| [292] | 1.238 | 1.533 | 1.616 | 1.144 | 1.166 | 1.109 | 0.753 | 0.446 | 0.726 | 0.823 | 0.947 | 1.072 | 1.145 | 2.016 | 1.926 | 2.319 | 2.404 | 2.486 | 2.549 | 2.325 |
| [411] | -0.066 | -0.057 | -0.037 | -0.072 | -0.078 | -0.039 | -0.047 | -0.059 | -0.060 | -0.055 | -0.039 | -0.033 | -0.033 | -0.032 | -0.018 | -0.021 | -0.024 | -0.021 | -0.020 | -0.017 |
| [421] | -0.129 | -0.126 | -0.119 | -0.190 | -0.168 | -0.144 | -0.136 | -0.114 | -0.100 | -0.043 | -0.064 | -0.137 | -0.127 | -0.169 | -0.124 | -0.130 | -0.141 | -0.127 | -0.103 | -0.102 |
| [422] | 0.005 | -0.016 | -0.001 | -0.014 | -0.014 | -0.001 | 0.004 | 0.011 | 0.014 | 0.013 | 0.009 | 0.003 | 0.003 | 0.003 | -0.007 | 0.009 | 0.000 | 0.005 | 0.006 | 0.007 |
| [431] | -0.030 | -0.027 | -0.025 | -0.027 | -0.037 | -0.031 | -0.024 | -0.029 | -0.032 | -0.031 | -0.030 | -0.030 | -0.028 | -0.029 | -0.026 | -0.007 | -0.015 | -0.009 | 0.001 | -0.006 |

Source: Prepared by the authors. For the content of each SITC group, see annex A1.

Table 5

Colombia and the United States: agricultural product groups of the International Standard Classification for International Trade (SITC) classified by category of (dis)advantages

| Category | Meaning | SITC Groups | TOTAL |
|----------|--|---|-------|
| K_1 | Time-sustainable comparative advantages | [034] [071] [292] | 3 |
| K_2 | Potentially time-sustainable comparative advantages | [037] [057] [061](E) [062](E) | 4 |
| K_3 | Weak advantages or disadvantages | [011] [016] [023] [025] [035] [045] [046] [047] [072] [075] [091] [121] [211] [212] [231] [245] [246] [247] [248] [261] [265] [268] [422] | 23 |
| K_4 | Weak advantages or disadvantages in fine | [001] [036] [043] [048] [054] [058] [059] [074] [111] [112] [122] [291] [411] [431] | 14 |
| K_5 | Potentially time-recurrent comparative disadvantages | [022](C) [024](C) [056] [073] [223] | 5 |
| K_6 | Time-recurrent comparative disadvantages | [012] [017] [041] [042](C) [044](C) [081] (C) [098] [222](C) [251] [263] [421] | 11 |

Source: Prepared by the authors.

Note: "E" identifies products that the United States continues to protect (sugar and its derivatives). "C" refers to products with comparative disadvantages (K_5 and K_6) to which Colombia applies a provisional protectionist regime.

In contrast, category K_6 includes 11 groups in which production could be displaced by United States imports, while in category K_5 there are five groups for which that possibility may exist, albeit to a lesser extent. Thus, the FTA poses a threat to 16 of the 60 groups analyzed, more than twice the number of groups for which it represents an opportunity. In table 5, the letter "C" indicates that the FTA authorizes Colombia to apply provisional protectionist regimes (see tables 1 and 2) to a portion of the 16 threatened groups; but only six have this benefit. Thus, the measures in question will be unable to (provisionally) mitigate imports in the other 10 unprotected groups and thereby mitigate the negative effects on their production.

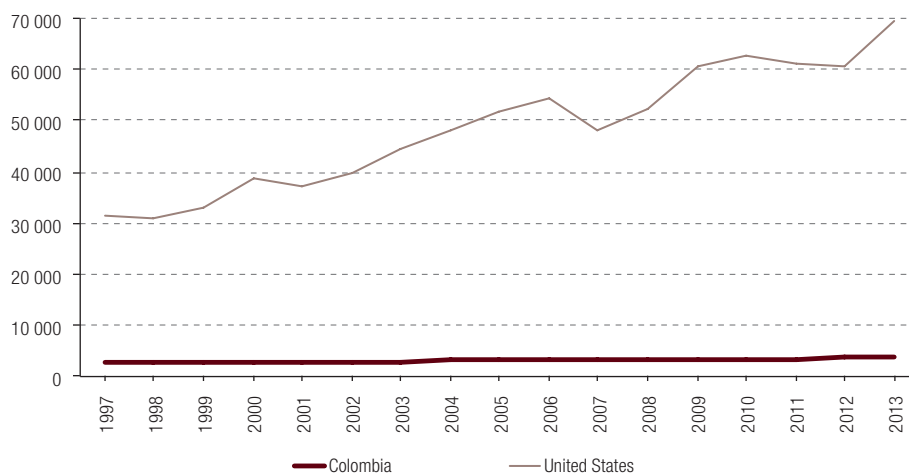
The other 37 groups belong to K_3 and K_4 . Regardless of the provisional protectionist regimes that Colombia or the United States could apply, the existence of (dis)advantages is zero or weak. These groups would not be threatened by imports from the United States; but no increase in Colombian exports should be expected either. Thus, the free trade agreement is of no interest to over half of the groups studied.

The distribution of the groups studied across the six categories of comparative (dis)advantage shows that the general level of advantage attained by Colombia with respect to the United States is low. This calls into question the claim that the FTA generates new business and employment opportunities in agricultural products.⁹

A question that arises from these findings is why Colombia displays this level of comparative advantage. Part of the answer relates to the average productivity of agricultural producers, since improving such productivity helps to lower relative costs and thus stimulate comparative advantages. World Bank data afford an initial idea of the productivity in question, through a proxy variable that measures the value-added per worker to the agricultural activity (livestock, forestry, fishing, hunting and agriculture). In 2013 (the latest year with data available for both Colombia and the United States), this value was equivalent to US\$ 3,858 (at constant 2005 prices) in Colombia and US\$ 69,457 in the United States — in other words roughly 18 times more. In fact, between 1997 (the first year with data available) and 2013, the value in Colombia never surpassed US\$ 4,000, whereas in the United States it rose from US\$ 31,577 to US\$ 69,457 (see figure 4). To eliminate or at least reduce this productivity gap requires improving the comparative advantages of Colombian agricultural products in general, going beyond the few specific cases in which there are advantages.

⁹ Website of the Ministry of Trade, Industry and Tourism, heading "19 preguntas del Acuerdo" [online] <http://www.mincit.gov.co/tlc/publicaciones.php?id=33180>.

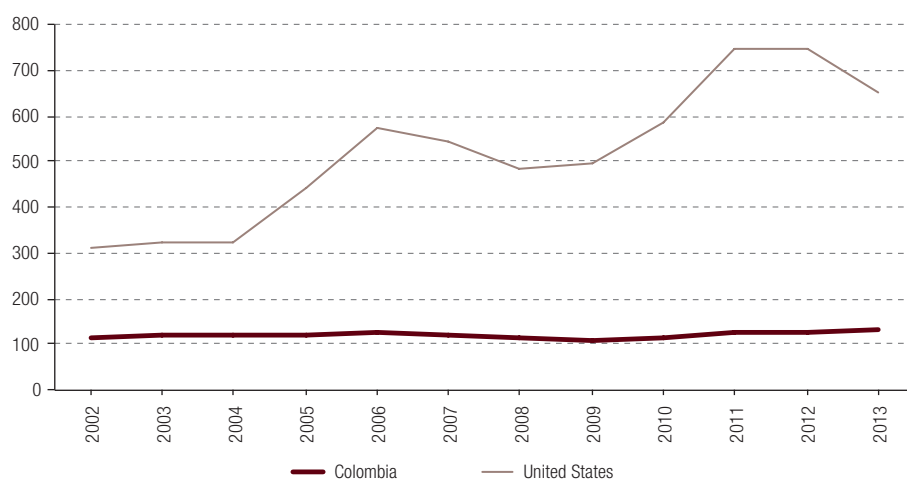
Figure 4
Colombia and the United States: value added per worker in the agriculture sector, 1997-2013
(Dollars at 2005 prices)



Source: World Bank [online] <http://datos.bancomundial.org/indicador/EA.PRD.AGRI.KD>.

This mainly reflects the use of fertilizers (nitrogenous, phosphate and potassium, among others). According to Wang and others (2015), fertilizer use is the main factor explaining why agricultural productivity in the United States in 2011 was double the 1948 level. In 2013, 649 kg of fertilizer were used per hectare of arable land in the United States compared to 132 kg in Colombia. In fact, fertilizer consumption in both countries has trended up since 2002; but, as figure 5 shows, in 2013 Colombia was still below the United States level of 2002. This helps to explain the productivity differential between the two countries and hence the general level of Colombia's comparative advantages relative to the United States.

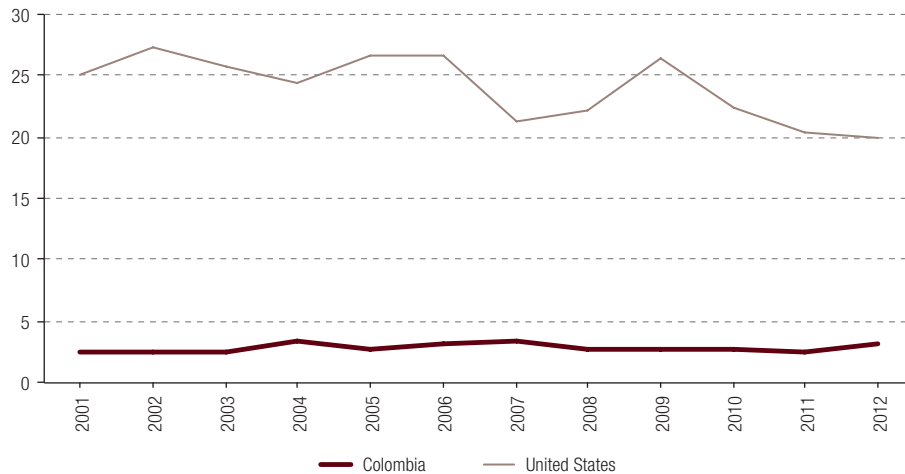
Figure 5
Colombia and the United States: fertilizer consumption, 2002-2013
(Kilograms per hectare of arable land)



Source: World Bank [online] <http://datos.bancomundial.org/indicador/AG.CON.FERT.ZS>.

According to Wang and others (2012), the role played by public support for productivity, through subsidies for the purchase of capital (machinery, equipment and other fixed assets) also needs to be recognized, along with research and development (R&D) activities. Here too, there is a significant difference between Colombia and the United States. According to data from the Food and Agriculture Organization of the United Nations (FAO), Colombian public expenditure amounted to US\$ 3.13 for every US\$ 1 million of agricultural production in 2012, compared to US\$ 19.91 in the United States —roughly six times as much (see figure 6). As in the case of fertilizer use, this also helps to explain the productivity gap between the two countries and thus the general level of Colombia's comparative advantages with respect to the United States.

Figure 6
Colombia and the United States: public spending in support of agricultural activities 2001-2012
(Dollars for every US\$ 1 million of agricultural production)



Source: Food and Agriculture Organization of the United Nations (FAO), [online] <http://faostat3.fao.org/download/I/IG/S> y <http://faostat3.fao.org/download/Q/QV/E>.

The foregoing contributes to a general understanding of why Colombia does not display many comparative advantages over the United States in agricultural products. A more in-depth analysis would involve constructing representative samples of Colombian and United States firms, associated with each of the 60 SITC groups studied. Data would then be collected on the variables explaining the comparative advantages as measured in this study: individual productivity, cost structure, technology, size, location, financial indicators and transport and marketing modalities, among others. Then, an econometric model could be developed to find the most significant statistical relationship between this indicator and some of the selected variables. Depending on the relationship found, recommendations could be made for improving the comparative advantages of the different Colombian agricultural products with respect to their United States counterparts.

VI. Conclusion

This study finds that Colombia displays comparative advantages with respect to the United States, which are (potentially) sustainable through time, in just seven of the 60 groups of agricultural products. Nonetheless, the United States can continue to protect itself in two of these seven groups. The remaining 53 groups display no (dis)advantage, weak (dis)advantages or (potentially) recurrent disadvantages without benefiting from provisional protectionist regimes. This shows that Colombia is insufficiently

competitive to take advantage of the opportunities offered by the FTA with respect to the products studied. These results are obtained by measuring the comparative advantages revealed through trade, calculated by the CEPII and used in this study to perform this measurement as accurately as possible.

The RCA index allows for a diagnostic of the capacity to produce with lower relative costs or differentiation, or both. Nonetheless, the purpose of the RCA index is not to determine the factors underlying that capability; so, the logical continuation of the present research would be to investigate those factors. As noted above, these generally relate to a productivity gap between Colombia and the United States, which stems, among other things, from a significant differential in fertilizer use and in public-sector support in the two countries. Identifying the underlying factors will make it possible to find various ways of stimulating or consolidating the advantages discussed here. This is essential for avoiding —or at least limiting— the substitution of imports from the United States for Colombian agricultural production, while at the same time promoting growth through exports to the United States. Future research should therefore analyse the economic policy measures that Colombian public entities plan to implement, or have already implemented, to make the FTA a genuine tool for promoting growth in agricultural production and hence the country's development.

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Annex A1

Table A1.1

The 60 groups studied from the Standard International Trade Classification (SITC)

| | |
|------|---|
| 001 | Live animals other than animals of division 03 |
| 011 | Meat of bovine animals, fresh, chilled or frozen |
| 012* | Other meat and edible offal of meat, fresh, chilled or frozen |
| 016 | Meat and edible meat offal, salted, in brine, dried or smoked; Edible flours of meat or meat offal |
| 017 | Prepared or preserved meat and meat offal, n.e.s. |
| 022 | Milk, cream and milk products, other than butter or cheese |
| 023 | Butter and other fats and oils derived from milk |
| 024 | Cheese and curd |
| 025 | Eggs, birds', and egg yolks; egg albumin |
| 034 | Ofish, fresh (live or dead), chilled or frozen |
| 035* | Fish, dried, salted or in brine; smoked fish |
| 036 | Crustaceans, molluscs and aquatic invertebrates, whether in shell or not, fresh (live or dead), chilled, frozen, dried, salted or in brine; Crustaceans, in shell, cooked by steaming or boiling in water |
| 037 | Fish, crustaceans, molluscs and other aquatic invertebrates, prepared or preserved, n.e.s. |
| 041 | Wheat (including shelled) and meslin, unmilled |
| 042 | Rice |
| 043 | Barley, unmilled |
| 044 | Maize (other than sweet corn), unmilled |
| 045 | Cereals, unmilled (other than wheat, rice, barley and maize) |
| 046 | Meal and flour of wheat and flour of meslin |
| 047 | Other cereal meals and flours |
| 048 | Cereals preparations and preparations of flour or starch of fruits or vegetables |
| 054 | Vegetables, fresh, chilled, frozen or simply preserved (including dried leguminous vegetables); roots, tubers and other edible vegetable products, n.e.s., fresh or dried |
| 056 | Vegetables, roots and tubers, prepared or preserved, n.e.s. |

Table A1.1 (concluded)

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|------|---|
| 057 | Fruit and nuts (not including oil nuts), fresh or dried |
| 058 | Fruit, preserved, and fruit preparations (excluding fruit juices) |
| 059* | Fruit juices (including grape must) and vegetable juices |
| 061 | Sugars, molasses and honey |
| 062 | Sugar confectionery |
| 071 | Coffee and substitutes for coffee |
| 072 | Cocoa |
| 073 | Chocolate and other food preparations containing cocoa, n.e.s. |
| 074 | Tea and mate |
| 075 | Spices |
| 081 | Feeding stuff for animals (not including unmilled cereals) |
| 091 | Margarine and shortening |
| 098 | Edible products and preparations, n.e.s. |
| 111 | Non-alcoholic beverages, n.e.s. |
| 112 | Alcoholic beverages |
| 121 | Tobacco, unmanufactured; tobacco refuse |
| 122* | Tobacco, manufactured |
| 211 | Hides and skins (except furskins), raw |
| 212 | Furskins, raw (including heads, tails, paws and other pieces or cuttings, suitable for furriers' use), other than hides and skins of group 211 |
| 222 | Oil-seeds and oleaginous fruits of a kind used for the extraction of "soft" fixed vegetable oils (excluding flours and meals) |
| 223 | Oil-seeds and oleaginous fruits, whole or broken, of a kind used for the extraction of other fixed vegetable oils (including flours and meals of oil-seeds or oleaginous fruit, n.e.s.) |
| 231 | Natural rubber, balata, gutta-percha, guayule, chicle and similar natural gums, in primary forms (including latex) or in plates, sheets or strip |
| 245 | Firewood (other than wood waste) and charcoal |
| 246 | Wood in chips or particles and wood waste |
| 247 | Wood in rough form or roughly squared |
| 248 | Wood, simply worked, and railway sleepers of wood |
| 251 | Pulp and waste paper |
| 261 | Silk |
| 263 | Cotton |
| 265* | Vegetable textile fibres (other than cotton and jute) |
| 268 | Wool and other animal hair (including wool tops) |
| 291 | Crude animal materials, n.e.s. |
| 292 | Crude vegetable materials, n.e.s. |
| 411 | Animal oils and fats |
| 421* | Fixed vegetable fats and oils, "soft" |
| 422* | Fixed vegetable fats and oils, other than "soft" |
| 431* | Animal or vegetable fats and oils, n.e.s. |

Source: United Nations Statistics Division, "SITC Rev. 3" [online] <https://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=14&Top=2&Lg=1>.

Note: The description shown for groups marked with an asterisk has been simplified. Further details can be found at the source.

