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New directions of trade for the agri-food industry: a disaggregated approach for different income countries, 1963–2000

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Abstract The principal objective of the present study is to explain the changes in the direction of agri-food trade flows during the second half of the twentieth century. Since the end of the Second World War, trade has tended to be concentrated among developed countries, breaking the pattern of complementarity among industrialized countries and developing countries from the first wave of globalization. Elsewhere, agricultural exports from developing countries to countries of similar income have significantly increased since the 1990s. To compare and explain the evolution of different trade directions, the present article estimates the gravity equation for the bilateral volume of agri-food trade, analyzed separately in four categories of trade flows based on the development level of countries. Specifically, we have used the UN-COMTRADE database to construct a data panel for bilateral trade among 30 reporting countries and 39 partner countries with a significant presence in international markets for the period 1963–2000. The following conclusions can be extracted from the present study. Firstly, while other types of trade, such as manufactures, enjoyed greater multilateral liberalization of their markets, strong market intervention caused them to base their growth on the proliferation and success of regional trade agreements in the North. As a result, agri-food trade concentrated progressively on developed economies. Secondly, the latest liberalization of some preferential trade agreements gave rise to new increases in agricultural trade, this time in South–South flows. Finally, the negative sign of income demand elasticity for imports of agricultural products from Southern

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countries demonstrates that the latter behaved like inferior goods and also explains why the export growth of such countries suffered a brake on such expansion.

Keywords Agri-food trade · Gravity equation · Regional trade agreements · Agri-food industry

JEL classification F14 · M16 · N50 · N70 · Q17

1 Introduction

From the mid-nineteenth century until the First World War the international economy witnessed a significant increase in market integration; this period is often referred to as the first wave of globalization. Industrialization, which took place principally in Europe, and an increase in incomes, accompanied by the reduction of transport costs, market liberalization and a stable economic setting provided by the gold standard were the principal motors of this process. The expansion of trade was one of the key elements in this first wave of globalization, together with the boom in capital movements and in transoceanic migrations.

Agricultural and food products played a central role in the growth of exchanges, which from 1870 onward accounted for approximately 50 % of total trade. Trade was inter-industrial, within which exchanges of manufactures for primary products between countries with very different patterns of specialization were predominant (Lewis 1952; Findlay and O'Rourke 2007). The increased specialization of the most developed European countries in manufactured products generated an intense demand for raw materials and foodstuffs; such needs were met both by various lesser-developed European countries and the rest of the world (Aparicio et al. 2009). Most other countries were integrated into international trade, principally as exporters of primary products and importers of manufactures (Lewis 1970; Williamson 2006). Among the peripheral countries, some had excellent economic results based on export-led models; this was, for example, the case of Argentina (Bertola and Williamson 2006; Bulmer-Thomas 1987; Cortés Conde 1992; Gerchunoff and Llach 2011).

After 1914, the globalization process was interrupted as a result of the outbreak of the First World War, which was followed by a far-reaching collapse, due to the depression of the 1930s and the Second World War (O'Rourke and Williamson 1999).

International trade and market integration were seriously affected, both conjuncturally due to the two wars and more permanently as a result of the policies implemented by the majority of countries and which had as a deliberate objective the restriction of imports (Hynes et al. 2012). Agri-food trade experienced a severe contraction, in both volume and especially in value, due to the fall in its relative prices (Ocampo and Parra-Lancourt 2010). The countries most specialized in the export of primary products, and therefore most dependent on such exports for their economic growth, suffered such policies most severely. For example, the South American countries, with a very high participation in international agri-food trade

prior to 1914, experienced severe difficulties which would have an important influence on their changing model of growth following the Second World War (Pinilla and Aparicio 2014).

In the second half of the twentieth century, the integration of the world economy accelerated, once more especially in the Western countries, with the establishment of a new economic order which encouraged a stable environment of generalized growth. The pillars on which this new international economic order was based were the Bretton Woods monetary system, which provided great stability to exchange rates until its rupture at the beginning of the 1970s, and the deep-seated liberalization in the exchange of manufactures, as a consequence of the successive rounds of GATT. Although at first this process did no more than recover past levels of integration, since approximately the 1960s the integration process accelerated at an unprecedented rhythm, often called the second wave of globalization, in which trade once more played a key role (Findlay and O'Rourke 2007). The pattern of international trade came to be intra-industrial, predominantly between advanced economies with similar factor endowments (Krugman 1995). In addition, there was a profound change in the composition of international trade, characterized by an increase in the share of manufactured products and a sharp decline in that of agricultural and food products. In 1951, the latter accounted for 43 % of the value of total world trade. In the year 2000, this figure was only 6.7 %. Part of this declining importance is explained by the relative fall in their prices, but nevertheless the decrease in volume was also substantial (Serrano and Pinilla 2011a, 2012).

This new process of market integration was far removed from the pattern of complementarity developed throughout the first globalization. Both total trade and trade in agricultural products and food have become progressively concentrated on the exchange of goods among developed countries. Nations which historically were more dependent upon the export of agricultural products and food saw their traditional market shares fall, while the more developed countries increased their exchanges. Thus, the regions most dependent on the export of agricultural products (Africa and Latin America) witnessed a fall in their share of world agricultural trade.[1] Moreover, some of these countries not only saw their exports decline in relative terms, but also experienced a sharp deterioration in the ratio of agricultural exports to imports. Thus, Africa and Asia became net importers of agricultural products where they had once been net exporters. By contrast, the high-income nations, and in particular Europe, increased their share of world agricultural trade.

Table 1 reflects this decline in the share of developing countries, of approximately 10 percentage points from the 1960s until the end of the century. The counterpart has been the increasing weight of the developed countries, especially those of the European Union, in world agricultural markets. Thus, Europe represented 30.7 % of world agri-food exports in the 1950s while its share by the end of the century grew to 46.9 %. Such variations in performance were not unaffected by either the economic policies followed in diverse countries or by the obstacles placed in the way of international agricultural trade. The governments of the more developed countries supported agriculture more than any other sector,

[1] The Argentinean case is paradigmatic: Cadenazzi (2012), Hora (2013), Llach (2006).

Table 1 Percentage of participation of the developed and developing countries in the international trade of agri-food products

	1961–1963	1977–1979	1998–2000
Developed countries	**57.87**	**64.97**	**68.94**
Europe	30.67	39.82	46.94
Canada and USA	19.42	19.94	16.77
Oceania (developed)	7.29	4.90	4.86
Developing countries	**41.87**	**34.71**	**30.90**
Asia (developing)	15.60	12.46	15.29
Latin America and the Caribbean	14.79	14.95	12.09
Africa	11.49	7.30	3.52

Source: Authors' elaboration, using UN-COMTRADE (2003)

while many developing economies discriminated against it.[2] On this last point, the case of Latin America is especially notable, since many of its countries opted in the early stages of the period to develop policies based on import-substituting industrialization, which greatly penalized their agro-exporting sectors. Clearly, Africa has by far been the continent which has lost most of its quota in agri-food trade. From the 1950s onward, its exports were affected by the presence of early shocks, which may be related to decolonisation, a process that affected the majority of the countries in the region and had a significant impact on foreign trade, reflected in a loss of exports to international markets almost from the outset, and especially to the historic metropoli with which they maintained special relationships. In many cases, the change of power also affected the position of the European settlers, which in some cases had an important weight in export agriculture (Karshenas 2001).

The other side of the coin in regional participations in exports is offered by imports. Thus, while Europe and North America significantly retracted in percentage terms (they moved respectively from 59 to 19 % of world exports in 1952–1959 to only 48 and 14 % en 1994–2000), those of Asia more than doubled (from 14 to 29 % in this same period) (Serrano and Pinilla 2011b).

Table 2 shows, for the two final decades of the twentieth century, the directions of agri-food trade and offers a view of how the share of agricultural trade among the countries of the North has been consolidated and even deepened. Approximately, 80 percent of agricultural and food exports from the developed countries are destined to other developed countries. Within this group, the boom in intra-EU trade has been very important, especially in the initial decades of the process of European integration (Pinilla and Serrano 2009). The same has occurred, from the 1990s on, with the surge of trade in the North American region, coinciding with the increasing importance of the North American Free Trade Agreement (NAFTA).

It is also important to underline here that the composition of international agricultural trade asymmetrically affected exchanges among the diverse economic regions. The less developed countries exported basic products and products with a

[2] In many countries of the developing world, the exports sector was penalized, through diverse economic policy measures (Anderson 2009).

Table 2 Destination of agri-food exports, by region (percentage)

Origin/destination		North	EU-15	Canada and USA	South	Asia and the Pacific	Latin America and the Caribbean	Near East and North Africa	Sub-Saharan Africa
Near East	1980	**72**	65	1	**28**	2	0	23	4
and North Africa	1985	**61**	44	7	**39**	2	0	35	1
	1990	**68**	51	6	**32**	3	1	27	1
	1995	**64**	43	5	**36**	4	1	30	1
	2000	**63**	42	5	**37**	4	1	30	2
Sub-Saharan Africa	1980	**85**	71	9	**15**	3	0	3	8
	1985	**86**	71	14	**14**	4	0	2	8
	1990	**75**	67	5	**25**	5	0	2	18
	1995	**71**	59	5	**29**	8	1	5	14
	2000	**61**	46	5	**39**	11	1	8	19
Latin America and the Caribbean	1980	**75**	44	23	**25**	2	18	4	1
	1985	**75**	43	25	**25**	4	11	9	2
	1990	**75**	39	31	**25**	4	14	6	1
	1995	**67**	33	27	**33**	8	19	5	2
	2000	**68**	28	30	**32**	7	18	5	1
Asia and the Pacific	1980	**61**	24	12	**39**	27	2	9	2
	1985	**62**	21	14	**38**	24	1	10	2
	1990	**63**	21	12	**37**	26	2	8	2
	1995	**57**	16	12	**43**	32	1	7	2
	2000	**57**	15	14	**43**	32	1	7	2
EU-15	1980	**82**	76	4	**18**	2	3	10	4
	1985	**84**	76	8	**16**	2	2	9	3
	1990	**88**	82	5	**12**	2	2	6	2
	1995	**89**	79	4	**11**	2	2	5	2

Table 2 continued

Origin/destination		North	EU-15	Canada and USA	South	Asia and the Pacific	Latin America and the Caribbean	Near East and North Africa	Sub-Saharan Africa
	2000	**89**	73	6	**11**	3	2	5	2
Canada	1980	**65**	29	14	**35**	13	14	6	2
and USA	1985	**67**	22	22	**33**	11	12	7	3
	1990	**70**	22	24	**30**	12	10	6	1
	1995	**67**	18	25	**33**	15	11	6	1
	2000	**67**	13	32	**33**	12	14	6	1

Source: Authors' elaboration, using UN-COMTRADE (2003). The South comprises developing countries and the North is integrated by developed countries, following UN country classifications based on development level

low level of processing, while the high-income countries largely monopolized the market in highly processed products, precisely those which have shown throughout this period greater potential for growth (Serrano and Pinilla 2013).

The developing countries have depended on exports to their traditional markets, which is to say Old Europe and rich North America. However, this position has progressively changed. The agricultural exports of developing countries to countries of similar income have significantly increased. These already represented 31 percent of total agricultural and food exports by 1990, a figure which increased to 38 percent at the end of the last century. This new trade pattern, with an increasing importance on the direction of South–South flows, is common to all the developing regions, and this is possibly related to the growth of the so-called emerging economies, increasing market liberalization and the success of some trade agreements among developing countries from the 1990s on.[3]

Lastly, the governments of the more developed countries supported agriculture more than any other sector. By contrast, in the developing countries, it is habitual for inward-looking policies to discriminate in favor of industry as regards agriculture. Within agriculture, the sector oriented toward the production of foodstuffs for the domestic market received greatly support than the export market-oriented production (Anderson 2009).

Given this context, the principal objective of the present study is to explain the changes in the directions of agricultural trade flows during the second half of the twentieth century. Our hypothesis is that these substantial changes in agricultural trade flows may be explained mainly by the successful liberalization of regional exchanges through various types of regional trade agreements, in a context of strong agricultural protectionism and due to the diverse specializations in trade in agricultural goods among developed and developing countries.

With regard to the impact of regional trade agreements (RTAs), the European Union (EU)[4] in particular was especially successful in liberalizing the exchange of agri-food products among its members. Agricultural trade among them (taking the EU-15 as reference), displayed a spectacular increase, from 17.1 % of world agricultural exports in 1959–1966 to 26.8 % in 1994–2000 (Serrano and Pinilla 2011a).[5] In other regions of the world, such as Latin America, the effect of these agreements upon agricultural trade was much lesser (Serrano and Pinilla 2008). Merely in the 1990s, the Uruguay Round of GATT was able to produce a certain liberalization of the markets in agricultural products and a reduction of protectionism. From that point on, and also as a consequence of the dynamism of the Asian countries and of the stimulation of RTAs among developing countries, a new pattern emerged in the exchanges of agricultural products, defined by the boom in trade among the economies of the South.

Secondly, the pattern of specialization in trade in agricultural products was diverse, at least until the 1990s, among developed and developing countries. The

[3] This boom in South–South trade is even more important in manufactured products (Hanson 2012).

[4] Hereafter, we shall use the term European Union (EU) for all those institutions which preceded it.

[5] See also Dell'Aquila et al. (1999) or Diao et al. (1999), who demonstrate the extraordinary upsurge in intra-regional trade in various geographical areas.

developed countries have strengthened their specialization in high-value products and transformed agricultural products, while the developing countries continue to concentrate their exports on bulk and plantation products. This could have damaged the dynamism of the agri-food agricultural trade of these latter countries, since the lower income elasticity of such products has affected the growth in their exports. Such different specializations in the export of agri-food products have their roots in the decades prior to the Second World War. It may be considered that these were by 1960 strongly coherent with their factor endowment and institutional quality. The European advantage in transformed and high-value products may be placed in this way in relation to their technological advantage and to the process of industrialization. Changing that specialization is not an easy task. As several studies have made clear, it involves substantial costs ('cost discovery') (Hausmann and Rodrik 2003). Furthermore, the speed at which that change may be produced may be highly variable and will depend on the density of the product space near the area where each country has developed its productive capabilities (Hausmann et al. 2007). On the other hand of the achievement of this change, important consequences are derived from the point of view of economic growth (Hausmann and Klinger 2006). Precisely, some developing countries which have been able to most vary their composition toward high-value products display an improvement in their agri-food agricultural exports.[6]

To test whether our hypotheses are correct, the present article estimates the gravity equation for the bilateral volume of agricultural trade, analyzed separately in four categories of trade flows: trade between high-income countries (N–N), trade flows which originate in high-income countries and are destined to low-income countries (N–S); trade flows whose origin is in developing countries and are exported to the developed world (S–N); and trade flows between low-income economies (S–S). Concretely, using the UN-COMTRADE (2013) database, we have constructed a data panel for bilateral trade among 30 exporting countries and 39 importing countries with a significant presence in international markets for the period 1963–2000.

The empirical success of this equation in explaining trade patterns has engendered numerous subsequent articles, although very few have a long-term perspective, and nor have they concentrated on the agri-food trade and compared it to trade in different directions.

Finally, it should be emphasized that the study shows how a correct estimation of the gravity equation must include fixed effects by country pairs; these serve as an approximation of "multilateral resistance", following the suggestions made by Anderson and van Wincoop (2003). In addition, the standard errors must be corrected using a Prais-Winsten estimation, as otherwise the models are subject to problems of specification.

The following conclusions can be extracted from the present study. Firstly, while other types of trade, such as manufactures, enjoyed greater multilateral liberalization of their markets, strong market intervention caused them to base their growth

[6] In the late twentieth century, significant changes were observed in this specialization, with significant economic and social effects. See the cases of Chile (Solbrig 2008), Costa Rica (Botella 2012) and Peru (Velazco and Velazco 2012: 164–166).

on the proliferation and success of RTAs in the North. As a consequence, agricultural trade concentrated progressively on developed economies. The latest liberalization of GATT gave rise to new increases, this time in South–South agricultural trade. Secondly, income demand elasticity for imports has a negative sign for agricultural products from the Southern countries; this demonstrates that such products behaved like inferior goods and that for this reason these countries suffered a brake on the growth of their exports.

2 Methods

As described earlier, the process of the integration of agri-food markets during the second half of the twentieth century was especially important among high-income countries and then, in the 1990s, so were the latest increases in South–South trade flows. We would therefore like to study here the determinants of agricultural trade, employing a disaggregated approach to trade flows for different subsamples of countries.

To analyze the factors determining the changes in the direction of agricultural trade flows during a substantial part of the second half of the twentieth century, the present article estimates the gravity equation for the bilateral volume of agricultural trade, analyzed separately in four categories of regional trade flows. We use the data for bilateral trade flows published by the United Nations Statistics Division in the UN-COMTRADE database (2003). These data were taken from the figures for bilateral exports (FOB—free on board). The sample includes trade among 30 exporters to 39 markets, whose trade flows are representative of international trade flows in agri-food products.[7] With regard to the representativeness of the sample employed, in the 38 years covered, this varied from 66 to 76 % of international trade in agricultural products. It largely followed the trend of the complete series of world agricultural trade (Serrano and Pinilla 2010). The representativeness of the sample exceeds 95 % in the processed foods groups, those of high-value and other processed agricultural products, while basic and plantation products represent only approximately 50 %, due to the lower presence of low-income countries specialized in this type of products.[8]

[7] The countries included in each group are as follows:

South: Africa (Algeria, Ivory Coast, Egypt, Morocco, Nigeria and Sudan); Asia (China, India, Indonesia, Israel, Malaysia and Saudi Arabia); Latin America (Argentina, Brazil, Chile, Colombia, Ecuador, Nicaragua and Peru) **North:** Europe (Belgium-Luxembourg, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain and the United Kingdom); Japan; North America (Canada, Mexico and the United States); Oceania (Australia and New Zealand).

Nevertheless, due to the severe lack of data, exports from China, Ivory Coast, Nigeria, Sudan, Saudi Arabia and Uruguay to the remaining countries were eliminated. Also Algeria, Morocco, Peru, Nicaragua were eliminated as exporters because of the lack of data for the Nominal Rate of Assistance. Note that exports from the remaining countries to these countries remain in the sample. Thus, the sample comprises the trade flows among 30 countries of origin × 39 countries of destination × 38 years.

[8] The different representativeness of the sample over total world trade does not necessarily imply a bias in the results of the econometric model, since the only factor it involves is that there are fewer observations of countries specialized in basic products; nevertheless, we believe they that they are sufficient and that the representativeness of the sample is high.

We constructed export flows by volume for agricultural and food products, following the system of the Standard International Trade Classification (SITC, Revision 2)[9] (in 1995 US$) for the period 1963–2000. Trade in agricultural and food products is that included in the SITC groups 00-04.[10]

The database therefore consists of four data panels comprising trade flows among the countries included in the sample and classified, following the United Nations Statistics Division, according to their level of development.[11] Thus, trade flows are classified into four categories, the first of which is among high-income countries (N–N). As Table 2 shows, their bilateral trade flows achieved strong growth. The second is trade flows which originate in high-income countries and are destined to low-income countries (N–S). The third is trade flows whose origins are in developing countries and are exported to the developed world (S–N); their trade in primary products was based on previous stages and grew very slowly in the study period. The final category is trade flows between low-income economies (S–S), whose growth of exchanges accelerated in the final fifteen years of the last century.

We now propose the specification of the gravity equation we shall use. The empirical approach is based on the work of Feenstra et al. (1998), Bergstrand (1985, 1989) and Anderson and van Wincoop (2003). The success of this methodological approach in explaining international trade patterns has led economists to formally develop its theoretical foundations. The empirical validations of the gravity equation, such as those performed by Helpman (1987), Hummels and Levinsohn (1995), and Evenett and Keller (2002), conclude that the equation can be derived from different theoretical models. This is an eclectic vision of trade determinants which includes, in a complementary fashion, the Hecksher–Ohlin models with specialization (Anderson 1979; Deardorff 1984; Anderson and van Wincoop 2003) and the models of the New International Trade Theory with increasing returns and monopolistic competition (Helpman and Krugman 1985), allowing the gravity equation to be better reconciled with the theoretical models.

Applying logarithms, the functional form of the equation is as follows:

$$\begin{aligned} ln\,X_{ijt} = {} & \beta_1 + \beta_2 ln\,(Y_{it}) + \beta_3 ln\,(Y_{jt}) + \beta_4 ln(Ypcp_{it}) + \beta_5 ln(Ypcp_{jt}) \\ & + \beta_6 lnDist_{ij} + \beta_7 lnExcvol_{ijt} + \beta_8 Border_{ij} + \beta_9 Lang_{ij} \\ & + \beta_{10} Both\_in\_RTA_{ijt} + \beta_{11} One\_in\_RTA_{ijt} + \beta_{11} NRA_{ijt}\beta_{11} \\ & + GATT_{ijt} + \delta_{ijt} + \varepsilon_t \end{aligned} \tag{1}$$

where $\boldsymbol{X_{ijt}}$ represents agricultural exports flows, by volume, from country i to country j in year t, in 1995 US dollars (the series for each product group has been deflated by the respective price indices to obtain the volume series); $\boldsymbol{Y_{it}}$ **and** $\boldsymbol{Y_{jt}}$ are

[9] SITC Rev2 allows a long-run study. More modern classifications do not provide data after 1963.

[10] SITC groups: 00.Live animals, 22.Oil-seeds and oleaginous fruits, 26.Textile fibers, 06.Sugar, 07.Coffee, tea, cocoa, 01.Meat and meat preparations, 02.Dairy products and birds' eggs, 04.Cereals, 05.Vegetables and fruit, 08.Feeding stuff for animals, 09.Miscellaneous edible products and preparations, 11.Beverages, 12.Tobacco and tobacco manufactures, 41.Animal oils and fats, 42.Fixed vegetable fats and oils, 43.Animal or vegetable fats and oils, processed.

[11] https://unstats.un.org/unsd/methods/m49/m49regin.htm.

the real GDP of both the exporting country and the importing country, in year t, in 1995 US dollars (World Development Indicators (WDI, 2012); $Ypcp_i$, $Ypcp_j$: is the per capita GDP of both the exporting and importing countries, in year t, in 1995 US dollars (WDI CD-ROM 2004); $Dist_{ij}$ is the distance between the capitals of the countries of origin and destination (CEPII database); $Excvol_{ijt}$: is an indicator of exchange rate volatility in year t (estimation of the standard deviation of the first difference in the natural annual logarithm of the nominal bilateral exchange rate for the pair of countries in the ten-year preceding period t,[12] exchange rate data are drawn from WDI, 2012); $Border_{ij}$ is a dummy variable which takes the value of 1 if the countries have a common border and 0 otherwise; $Lang_{ij}$ is a dummy variable which takes the value of 1 if the countries share a common language and 0 otherwise; $Both\_in\_RTA_{ijt}$ is a dummy variable which takes the value of 1 if the two countries belong to the same following regional trade agreements (EU, NAFTA, CER, APEC, MERCOSUR, ANDEAN, ASEAN, GSTP) and 0 otherwise;[13] $One\_in\_RTA_{ijt}$ is a dummy variable which takes the value of 1 if only one country belong to the some of the following regional trade agreements (EU, NAFTA, CER, APEC, MERCOSUR, ANDEAN, ASEAN, GSTP) and 0 otherwise; NRA_{ijt} is a dummy variable which takes the value of 1 if the exporter country does not have agricultural assistance from the government and 0 otherwise; $GATT_{ijt}$ is a dummy variable aimed at capturing the impact of the various rounds of GATT. Concretely, $GATT_{63\text{-}94}$, is a dummy variable, used if the two countries belonged to that body prior to the Uruguay Round (1994). Additionally, $GATT_{94\text{-}05}$ is a dummy variable, employed if the two countries were members of GATT following the implementation of the agreements reached in the Uruguay Round of GATT (1994).

In the traditional proposal of the gravity equation, X_{ijt} represents the volume of trade flows between two countries. This depends on the geographical distance between the countries ($Dist_{ij}$), which is usually presented as an obstacle to trade and treated as an approximation of transport costs. It also depends on the size of their markets, which is usually approximated by the value of their income (Y_{it}, Y_{jt}), which permits us to observe that the potential of a country to offer (export) its products depends on its size, measured by GDP, while the foreign demand for these products will depend on the size and growth of the GDP of the importing country. As in the vast majority of studies, we also include multiple variables, such as geographical proximity (if the countries share a border) and cultural proximity (the existence of

[12] In constructing the exchange rate uncertainty measure, there is a certain amount of arbitrariness involved concerning the choice of the measure and the time period covered. In this paper, a 10-year time period is used, following Cho et al. (2002).

[13] The effects of the integration of the countries in the sample were studied according to the year of their integration into the following free trade institutions:

EU: European Union, previously the European Economic Community, (Austria, Germany, Belgium-Luxembourg, Denmark, Finland, France, Greece, Italy, Ireland, the Netherlands, Portugal, Spain and the United Kingdom)

EFTA: European Free Trade Association (Austria, Denmark, Finland, Norway, Portugal, United Kingdom).

NAFTA: North American Free Trade Agreement, previously CUSTA, Canada-US Free Trade Agreement (Canada, Mexico, United States).

historical or cultural ties, such as a colonial relationship or a common language). The coefficients of all of these variables are expected to be positive.

Following Bergstrand (1989), the equation introduced countries' per capita GDP ($Ycpc_{it,}$ $Ycpc_{jt}$). The inclusion of this variable in the model allows us to describe trade in different types of goods. According to Bergstrand, the coefficient of per capita income in the exporting country may be considered an approximation of its factor endowment. This coefficient is positive in the case of capital-intensive goods and negative for labor-intensive goods. Likewise, the coefficient of per capita income in the importing country serves to define the type of good and will produce a positive sign for superior goods and a negative one for inferior goods.

Following other authors (Cho et al. 2002; Rose 2000), meanwhile, the model includes different measures of the volatility of bilateral exchange rates ($\boldsymbol{Excvol_{ijt}}$). The objective in the present case is to examine the impact of exchange rate uncertainty on trade flows. This coefficient is expected to display a negative sign (i.e., the greater the instability of exchange rates, the lower the growth of trade between two countries).

With regard to the institutional context, the specification of the gravity equation has been refined in many studies to take account of factors that may limit or hinder trade. As in many studies, we have introduced dummy variables to analyze the effect of regional liberalization produced on the one hand, and the effects of the multilateral liberalization of international markets on the other. In the case of RTAs, we have constructed two dummy variables: Both_in_RTA is 1 if countries i and j are both members of the same RTA at time t and 0 otherwise. And One_in_RTA is 1 if the importer country i belongs to a RTA but the exporter j does not. A positive coefficient for both suggests trade creation. A coefficient which is positive for the first but negative for the second suggests trade diversion (this last case is only proposed for RTAs in the North). In the case of multilateral market liberalization, various dummy variables were included to explore the effects of membership of free trade associations, following the proposal made by Rose (2004). The aim is to examine the effects of the various rounds of the General Agreement on Tariffs and Trade (GATT). Both the result and the sign of this variable are uncertain.

In our case, we have also attempted to control for the effect of discriminatory policies, which were developed in some countries regarding export agriculture. It is very difficult to approximate these policies with a simple indicator. Nevertheless, we have attempted to do so using a dummy variable based on the Nominal Rate of Assistance (NRA) to export products. Anderson and Valenzuela (2008) estimate distortions and agricultural incentives from 1955 to 2007. We use as a proxy of distorsions the index of the Nominal Rate of Assistance to exportable agricultural goods. This dummy variable takes the value of 1 if the exporter country has a negative value higher than 0.10 and 0 otherwise. Given that for some countries and years, Anderson and Valenzuela (2008) do not provide this datum, we have assumed in these cases that its value was the same as that first existing. For this reason, we have considered it safer to establish the limit for the dummy variable at −0.10. The variable in the case of North countries is always 0, because in these countries during the whole time horizon of the study farmers were strongly subsidized (this variable always takes positive values).

Lastly, in line with the recent work by Anderson and van Wincoop (2003), the equation includes "multilateral (price) resistance terms", which are proxied by dummy variables. The method consists of using country fixed effects for importers and exporters (Rose and van Wincoop 2001; Feenstra 2004; Baldwin and Taglioni 2006). It designates a dummy variable for a specific year and one per year. These variables reflect the effect of all the singularities of the exporting and importing nations that might affect trade between two countries and are not captured by the remaining variables specified in the empirical model. Finally, the model includes the error term (ε_t) which is assumed to be log-normally distributed.

With regard to the estimation technique, our aim is to overcome the limitations of previous research which has only taken into account the variations among the units of observation (cross-section analysis). The present study also examines the time variations within the observation units. The use of panel data increases the efficiency of the estimators and significantly reduces the potential problems caused by the omission of variables (Hiaso 1986). From this perspective, three types of data panel estimation are proposed: the first is the estimation of ordinary least squares (OLS) with the grouped panel; the second and third take into account the time variation, by the inclusion in the model of random effects and fixed effects, respectively.

In order to determine which of the three estimators is most efficient, the LM Breusch–Pagan test for random effects was employed; this permitted us to choose between OLS estimation of the grouped panel and estimation with random effects. Following the application of the Breusch–Pagan test, it was concluded that random effects are significant, and it is therefore preferable to use such an estimation rather than the grouped panel estimation. Similarly, to demonstrate that the inclusion of fixed effects was a more appropriate method than the other two we employed initially, various tests were performed. Firstly, the F test (Greene 2000) of the significance of fixed effects indicated that their estimations were better than when the OLS estimation of the grouped panel was employed. Secondly, the Hausman test demonstrated that the estimators of random effects and of fixed effects differ significantly and that the fixed effects model provides a better explanation of the sources of variation and is therefore more appropriate than the random effects model.

It is important to underline here that, despite having modeled temporal and spatial heterogeneity, according to a Wald test (Greene 2000) our model poses problems of heteroscedasticity and, according to the Woolridge test (Wooldridge 2001), problems of autocorrelation also exist. Lastly, the Breusch–Pagan test, used to identify problems of contemporaneous correlation in the residuals of the fixed effects model, likewise confirms the need to correct this problem. The above-mentioned problems of contemporaneous correlation, heteroscedasticity and autocorrelation can be solved jointly and were resolved by the estimation of panel-corrected standard errors (PCSEs).[14] On the positive side, once the problems

[14] Beck and Katz (1995) demonstrate that the standard errors of PCSE are more precise than those of FGLS (Feasible Generalized Least Squares), the potential alternative to solving the abovementioned problems.

of estimator specification were corrected, the models continued to function well. The principal variables present the expected sign and are statistically significant.

On this point, and in addition to these technical reasons, there are also theoretical motives for preferring the fixed effects estimation (Feenstra 2004, 161–163). As stated earlier, Anderson and van Wincoop (2003) derived a gravity equation specification using a model that includes the presence of "multilateral (price) resistant terms", which was approximated using fixed effects by country pairs.[15] Furthermore, Baier and Bergstrand (2007) conclude that, for the analysis of trade agreements, the fixed effects approximation is best.

3 Results and discussion

Table 3 shows the estimation of the equation with PCSE and fixed effects for the four subsamples of trade flows (the "Appendix" offers the estimations with random effects and fixed effects). Firstly, the growth in exchanges accelerates in line with market size. For any export destination, whether North or South, the coefficients of the variable Yj are high and statistically significant; this occurs especially in flows whose origins were in developing countries. It is obvious that the demand for agri-food products from some emerging countries, such as China, has stimulated South–South trade. This is clearly shown by the results from our model, which underlines the strong stimulus to trade among developing countries as the market size of the importers increases.

Secondly, the slower growth of the exports of products originating in the South may be explained by the low-income elasticity with regard to the demand for exports toward their traditional markets. As shown in Columns 1 and 2 of Table 3, the coefficient of the per capita income of the developing countries ($Ypcp_j$), is negative and statistically significant (−1.278) for exports destined for the South, and also negative and statistically significant (−2.077) when their destination is countries of the North. Thus, the southern countries export basic products which, as we know, have a high negative elasticity in the more advanced economies. However, in the case of export from one northern country to another, the flow which grew most in the study period, this variable is not statistically significant. In exchanges from the North to the South, it is significant, although its coefficient is much lower than in exports coming from the South.

Thirdly, in the trade flows among high-income countries, here characterized as North–North, the coefficients of the variables EU, EFTA and NAFTA display positive signs and statistical significance, on Both_in and One_in demonstrating that the RTAs in the richest parts of the world created trade, and in some cases, such as Europe, did so from very early dates within the study period. Consequently, this result should be borne in mind in order to understand the intensification of North–North trade.

From the point of view of the exporters of the South, everything seems to indicate that their exchanges have faced strongly protected markets during a large part of the

[15] Following Feenstra (2004), the use of alternative methods produces similar results.

Table 3 Results of gravity equation for international trade in agri-food products disaggregated by country trade flows (based on their income level)

lnX_{ijt}	Agri-food trade PCSE estimation			
	S–S	S–N	N–N	N–S
lnY_{it}	−2.186***	−1.175***	−1.860**	0.368
lnY_{jt}	2.341***	2.987***	1.521***	0.842***
$lnYpcp_{it}$	3.847***	2.033***	2.385**	−0.442
$lnYpcp_{jt}$	−1.278**	−2.077**	−0.277	−0.667***
$lnDist_{ij}$				
$lnExcvol_{ijt}$	0.002	0.002	−0.010*	−0.001
$Border_{ij}$				
$Language_{ij}$				
$Both\_in\_MERCOSUR_{ijt}$	0.157			
$Both\_in\_ANDEAN_{ijt}$	0.104			
$Both\_in\_ASEAN_{ijt}$	−0.074			
$Both\_in\_GSTP_{ijt}$	0.094	0.154		
$Both\_in\_APEC_{ijt}$	0.538**	0.261	0.184	−0.192
$Both\_in\_NAFTA_{ijt}$		0.189	0.146	0.760***
$One\_in\_\ NAFTA_{ijt}$	0.778***	0.147	−0.248**	0.009
$One\_in\_\ EU_{ijt}$		0.029	0.085*	
$One\_in\_\ EFTA_{ijt}$		−0.048	0.247***	
$One\_in\_\ CER_{ijt}$		0.091	0.001	
$Both\_in\_EU_{ijt}$			0.694***	
$Both\_in\_EFTA_{ijt}$			0.647***	
$Both\_in\_CER_{ijt}$			−0.035	
NRA_{ijt}	−0.005	0.028		
$Gatt_{63\text{-}94}$	−0.166*	−0.145	−0.005	0.022
$Gatt_{94\text{-}00}$	0.177	0.209*	0.138	0.161
Constant	drop	drop	drop	drop
Country FE	*Yes*	Yes	*Yes*	*Yes*
No.observ.	10.061	10.597	14.401	15.121
R-squared.	0.512	0.630	0.835	0.567

Prais-Winsten estimation with PCSE and fixed effects. N–N: North–North trade, among high-income countries; N–S: North–South trade, exports from high-income countries to low-income countries; S–N: South-North trade, exports from low-income countries to high-income countries; S–S: South–South trade, among low-income countries

All variables are in logarithms, except binary variables (such as common border, language and different RTAs). ***, ** and * denote statistical significance at the 1, 5 and 10 % level respectively

period, at least until the 1990s. On this point, the coefficient of the GATT variable is extremely noteworthy; it does not display positive and statistically significant effects. It only shows positive and statistically significant effects for South–North flows following the Uruguay Round (see the coefficient of the variable $Gatt_{94\text{-}00}$, in Column 2 of Table 3).

On this point, it is very interesting to check how just the APEC variable displays a positive and significant result in the liberalization of markets among developing countries. These effects are not found for previous RTAs such as Mercosur, Andean Pact (Andean), Asean or, later, GSTP. It could be considered that this result is unsurprising. Regional trade agreements for developing countries were aimed more at the creation of integrated markets for industrial products which would facilitate the success of import substitution industrialization policies than at the integration of their agri-food markets. The Latin American case is paradigmatic, since the pessimism which existed concerning the possibilities of exporting manufactures, led for example the Economic Commission for Latin America (CEPAL) to recommend regional integration as an alternative, thereby broadening the internal market for this type of products (Bulmer-Thomas 1998: 345–357). In the European case, tariff dismantling was not only complete and relatively rapid for all product types, but instead the Common Agricultural Policy was in fact the first European policy, which greatly strengthened the integration of its market of agri-food products.

Lastly, the variable introduced to control for the impact of policies supporting or discriminating against export agriculture is not significant for any trade flow of the countries of the South. It is possible that this is due to the scarcity of the existing data; in some years, these have had to be estimated using those of subsequent years. It is also reasonable to assume that the fixed effects introduced in the model already control for the impact of these policies, and thus, these coefficients are not significant.

4 Conclusions

The objective of the present study has been to explain the fundamental changes experienced by agricultural trade in the second half of the twentieth century. The first of these was a progressive concentration of this trade among developed countries, while the second was a significant boom in agricultural trade among developing countries, since the final decade of the last century.

Our starting hypotheses were that these changes could be explained by regional specialization by the distinct types of countries in different agricultural products for export and also due to the different effects regarding agricultural trade in the established RTAs.

To explain the concentration of trade among developed countries, our gravity model has underlined that RTAs such as the EU, EFTA or NAFTA have significantly encouraged agricultural trade among developed countries. In contrast, the developing countries were faced with highly protected markets and a relative initial failure in their attempts to liberalize their regional markets.

In addition, the agri-food products exported by the Southern countries to any destination had a demand elasticity which was highly negative and statistically significant.

The boom from the final decade of the twentieth century in South–South agricultural trade can be explained, according to our model, by the fact that the demand for agricultural products and food from some emerging countries, such as China, has grown very quickly. This is clearly shown by the model's results, which underline the strong stimulus to trade among developing countries, as the market size of the importers increases.

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Appendix

Results of gravity equation for international trade in agri-food products disaggregated by country trade flows (based on their income level). See Table 4.

Table 4 Random Effects and Fixed Effects estimations

lnX_{ijt}	Agri-food exports Random Effects				Agri-food exports Fixed Effects			
	S–S	S–N	N–N	N–S	S–S	S–N	N–N	N–S
lnY_{it}	0.44***	0.47***	0.18***	0.95***	−2.74**	−1.51***	−1.56***	1.323***
lnY_{jt}	0.56***	1.34***	1.00***	0.90***	2.46***	3.15***	1.63***	0.409***
$lnYpcp_{it}$	0.97***	0.56***	0.41***	−0.11	4.49**	2.73***	2.07***	1.323***
$lnYpcp_{jt}$	0.11	−1.59***	−0.26***	−0.30***	−1.32***	−2.43***	−0.50***	0.409***
$lnDist_{ij}$	−1.18***	−0.07	−0.48***	−1.11***				
$lnExcvol_{ijt}$	0.03***	−0.01	−0.007**	0.01**	0.053***	0.01	−0.01***	0.011***
$Border_{ij}$	1.01**	0.37	0.55**	−0.72				
$Language_{ij}$	−0.56	0.99**	1.32***	0.49**				
$Both\_in\_MERCOSUR_{ijt}$	0.12				0.13			
$Both\_in\_ANDEAN_{ijt}$	−0.22				−0.20			
$Both\_in\_ASEAN_{ijt}$	0.50				0.81			
$Both\_in\_GSTP_{ijt}$	−0.08*				0.20***			
$Both\_in\_APEC_{ijt}$	0.90***	0.51***	0.28***	−0.02	0.69***	0.40***	0.35***	−0.34**
$Both\_in\_NAFTA_{ijt}$		−0.01	0.19	1.05**		0.04	0.27	1.23**
$One\_in\_ NAFTA_{ijt}$	0.80***	0.15**	−0.34***	0.28***	0.87***	0.20**	−0.30***	0.22**
$One\_in\_ EU_{ijt}$		−0.03	0.04*	0.50***		0.02	0.06**	0.43***
$One\_in\_ EFTA_{ijt}$		−0.11*	0.26***	0.64***		−0.19**	0.29***	0.78***
$One\_in\_ CER_{ijt}$		0.05	0.01	1.33***		0.32*	0.03	0.67***
$Both\_in\_EU_{ijt}$			1.03***				0.99***	
$Both\_in\_EFTA_{ijt}$			0.83***				0.93***	
$Both\_in\_CER_{ijt}$			0.27				0.22	
NRA_{ijt}	−0.04	−0.00			0.07	−0.06*		
$Gatt_{63\text{-}94}$	−0.33***	−0.08*	0.26***	−0.01	−0.28***	−0.11**	0.24***	0.02

Table 4 continued

lnX_{ijt}	Agri-food exports Random Effects				Agri-food exports Fixed Effects			
	S–S	S–N	N–N	N–S	S–S	S–N	N–N	N–S
$Gatt_{94\text{-}05}$	0.24***	0.28**	0.30***	0.07	0.26***	0.27***	0.29***	0.14**
Constant	−13.7***	−26.1***	−16.8***	−24.8***	−7.6***	−31.4***	−18.9***	−33.6***
Country FE					Yes	Yes	Yes	Yes
No. observ.	10.061	10.597	14.401	15.121	10.061	10.597	14.401	15.121
R-Squared.	0.40	0.45	0.56	0.43	0.29	0.19	0.44	0.27
LM Breuch–Pagan								
RE > OLS	0.00	0.00	0.00	0.00				
F-test FE > OLS					0.00	0.00	0.00	0.00
Hausman test FE > RE					0.00	0.00	0.00	0.00
Wald test					0.00	0.00	0.00	0.00
Woolridge					0.00	0.00	0.00	0.00

Prais-Winsten estimation with PCSE and fixed effects. N–N: North–North trade, among high-income countries; N–S: North–South trade, exports from high-income countries to low-income countries; S–N: South–North trade, exports from low-income countries to high-income countries; S–S: South–South trade, among low-income countries

All variables are in logarithms, except binary variables (such as common border, language and different RTAs)

***, ** and * denote statistical significance at the 1, 5 and 10 % level respectively

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