Ecological Economics 134 (2017) 140–149

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

Analysis

# Caloric unequal exchange in Latin America and the Caribbean

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ARTICLE INFO

*Article history:*
Received 26 April 2016
Received in revised form 30 December 2016
Accepted 2 January 2017
Available online 25 January 2017

*JEL Classification:*
F14
F18
N56
Q57

*Keywords:*
Caloric unequal exchange
Latin America
Terms of trade
Food

ABSTRACT

The existence of an unequal exchange between rich and poor countries has been well studied in the literature, explained by differences in labour costs that were reflected in the prices of traded goods. Research has also demonstrated that the failure to include environmental impacts in prices of traded goods concealed an ecologically unequal exchange. This paper contributes to the discussion with the newly coined concept of caloric unequal exchange that defines the deterioration of terms of trade in food in units of calories. Exports and imports to and from Latin America and the Caribbean are analysed for the period 1961 through 2011 in volume, value, and calories, for different groups of products. The study concludes that although calories exported by the region to the rest of the world are more expensive than those imported, the ratio is deteriorating over time. This trend is found to be dependent of the trading partner involved. The region is helping the rest of the world in supplying their diets at a lower cost. A side result is that globalisation is homogenising diets over time, concentrating most food consumption in a reduced number of products, and therefore increasing interdependency among countries and affecting food security.



## 1. Introduction

The insertion in global markets often induces changes in production patterns that go against the goal of self-sufficiency, understood as the situation in which food needs are covered with domestic production (FAO, 2002). This is a trend found in many Latin American countries which until now have prioritised production for exports instead of internal supply (Pengue, 2009). This trend has implied a gradual loss in food self-sufficiency and an increase in vulnerability to external factors, such as international prices. This is not the case for all areas of the world, as food self-sufficiency is one of the main goals of many countries or regions. This is the case of the European Union, which has achieved that goal through the Common Agricultural Policy (Guinea, 2014). The EU actually produces more food than it consumes, thus avoiding a supply side problem in recent decades (Candel et al., 2014).

Latin America and the Caribbean (LAC) is increasingly feeding the world. As it happens with other commodities, the terms of trade in the case of food products have been deteriorating over time (Section 4). This fact, along with the dependency the region has on exports to obtain foreign currency, induces countries to engage in a race-to-the-bottom as they compete with each other to sell the same products, driving export prices even lower. This is known as unequal exchange, which translates into the need for exporting more volume over time to be able to import the same volume.

This deterioration of the terms of trade was a concept advanced by economists in the region such as Prebish (1950, 1959), Singer (1950), or Furtado (1964, 1970), and gained the attention of authors such as Emmanuel (1972) or Amin (1976). Soon the concept evolved and incorporated environmental concerns, giving birth to the concept of ecologically unequal exchange, according to which exports of natural resources were not accounting for environmental externalities produced in exporting countries.

Many other studies have followed and contributed to this discussion in Latin America (Eisenmenger et al., 2007; Falconí and Vallejo, 2012; Giljum, 2004; Hornborg and Jorgenson, 2010; Hornborg, 1998, 2009; Machado et al., 2001; Muradian and Giljum, 2007; Pérez-Rincón, 2006a; Samaniego et al., 2014; Vallejo, 2010), and acknowledged by studies also measuring the loss of nutrients involved in food exports (Grote et al., 2005; Pengue, 2005). Through analysing the energy balance of agriculture (Pérez-Rincón, 2007), we decided to explore the unequal exchange of food trade, with an understanding that trade is not bad in itself, but unequal exchange is, as it means that many side-effects of production and trade of food are not accounted for .

It is in this regard that the article introduces the concept of caloric unequal exchange, which could be defined in the following way. It expresses the deterioration in the terms of trade of food traded when considering the cost of exported and imported calories. If unequal exchange allowed for discussions of power relationships in international trade,

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http://dx.doi.org/10.1016/j.ecolecon.2017.01.009
0921-8009/

and ecologically unequal exchange allowed us to incorporate trade-derived environmental externalities into the debate, it is our belief that caloric unequal exchange will allow for discussions of nutritional issues and diet quality when analysing food trade.

The paper explores this concept in the case of Latin America and the Caribbean with respect to the rest of the world, for the period 1961–2013, using the latest available data published by FAO.

The paper has two specific objectives:

1) To test the existence of caloric unequal exchange as defined above both in volume terms but also considering the cost of exported vs imported calories and their evolution over time.
2) To examine the loss of regional food self-sufficiency or the increase in external dependency.

## 2. Unequal Exchange, Ecologically Unequal Exchange, and Caloric Unequal Exchange

The concept of ecologically unequal exchange builds on the concept of 'unequal exchange' developed by Emmanuel (1972) and Amin (1976) and earlier by the work of structuralists Raúl Prebish (1959, 1950) and Furtado (1970, 1964). At that time, the concept focused on the unequal relationship found in traded goods between countries in terms of embodied labour time, which was reflected in prices being different and therefore developing countries showing deteriorating terms of trade. Ecologically unequal exchange put the focus on embodied land, natural resources and pollution (Bunker, 1984, 1985, 2007; Dorninger and Hornborg, 2015; Hornborg, 1998, 2009, 2014; Hornborg et al., 2007; Muradian and Giljum, 2007; Røpke, 2001). Exports of developing countries would be intensive in natural resources. However, their prices would not account for the value of the environmental externalities involved, implying a de facto transfer of wealth from poor to rich countries. Externalities would not be seen then as market failures, but rather as 'cost-shifting-successes' (Muradian and Martinez-Alier, 2001).

In fact, Hornborg (1998: 127) sees unequal exchange as emerging from an inverse relationship between productive potential and economic value. In his own words, "*'production' (i.e. the dissipation of resources) will continuously be rewarded with ever more resources to dissipate, generating ecological destruction and global, core/periphery inequalities as two sides of the same coin*".

The work of Bunker helped understanding how natural resource extraction shaped the underdevelopment of the Amazon in earlier decades (Bunker, 1984, 1985), opening room for new studies in what is today called political ecology, which deals with ecological distribution conflicts (Martinez-Alier and O'Connor, 1996).

Much work showing evidence of the imbalances in international trade and the burden of the exploitation of natural resources has been conducted, particularly in Latin America. A few examples for this growing literature follow. In the case of Brazil, Machado et al. (2001) showed that exports of non-energy goods had more embedded energy than imports. Embodied pollution in exports was also analysed (Muradian et al., 2002). The authors presented environmental load displacement from developed to developing countries. They estimated embodied pollution from 18 industrialized countries belonging to OECD versus the rest of the world, with the result that more air emissions were embodied in imports than in exports by rich countries. A study using material flow accounting in Chile showed how the burden of the exploitation of natural resources was unequally distributed and remained with the exporter (Giljum, 2004). Similarly, Pérez-Rincón (2006a) found a biophysical trade balance deteriorating and worsening terms of trade in the case of Colombia.

(Jorgenson, 2009, 2012; Jorgenson et al., 2010) conducted a series of tests on the existence of ecologically unequal exchange. He first tested the hypothesis for 66 lower-income countries, finding that those countries with high levels of primary exports to high-income countries, showed, at the same time, lower consumption-based environmental demand, measured by their ecological footprint (Jorgenson, 2009). Later he extended the analysis to deforestation (Jorgenson et al., 2010) and $CO_2$ emissions (Jorgenson, 2012).

Most of the analyses, though, focus on traditional extractive sectors such as mining and oil, with minor exceptions such as Austin (2010), who showed how developed economies transferred the environmental costs of their beef consumption to developing nations, the origin of their imports.

Our work contributes to this debate with the newly coined term 'caloric unequal exchange'. By this we mean the deterioration of the terms of trade when calories of foodstuff instead of volume are used. Our hypothesis is that, developing countries, and in our case, the countries of Latin America and the Caribbean, are increasingly exporting food products to the rest of the world at a lower cost to the calorie, expressing a new form of unequal exchange.

Analysing caloric unequal exchange is important as it brings together other issues regarding trade and food production globally, such as dietary diversity and malnutrition, food security and environmental concerns. Clearly, nutrition is not just about calories; however, calories can be used to bridge different scales of the analysis. Volume allows us to link the monetary value of food exports with production and therefore with land use and environmental impacts, as in ecologically unequal exchange. Calories allow us to link the former with nutrition. We are aware, though, that we are subject to simplification by using just one indicator, but we believe caloric unequal exchange may be expanded in the future to account for macro- and micro-nutrients.

## 3. Material and Methods

This study focuses on the region of Latin America and the Caribbean as defined by the UN Statistics Division.[1] The time window considered depends on the availability of data. For data on consumption, self-sufficiency, and variety of consumption, we use the period of 1961–2011. In the case of trade and terms of trade, we use data for the period 1986–2013 as reported by FAO.

The main source of data is FAOSTAT (FAO, 2016). We have used both data on food trade (starting in 1986) as well as food balances (starting in 1961). We present data in terms of volume, monetary values (in constant USD of 2005) and calories (kcal). Analysing LAC as a region means deducting intra-regional trade from trade statistics, as we are only interested in the relationship of the region as a block with the rest of the world. It is important to mention that, due to lack of data, Mexico is absent from the analysis for the year 1996, a fact that materialises in both tables and figures.

Several steps for processing data were followed, which are described below.

First, We use FAO's 14 major food groups: cereals (excluding beer), sugar crops, sugars and syrups, pulses, tree nuts, oil crops, vegetable oils, vegetables, fruit (excluding wine), roots and tubers, stimulants, spices, alcoholic beverages, miscellaneous. In this way, we focus our analysis on those groups that are more relevant for the region in terms of calories consumption. The study disaggregates the analysis for six major food product groups, according to their relative importance in terms of consumption: cereals (excluding beer), sugar and syrups, roots and tubers, pulses, vegetable oils and fruits (excluding wine).

Second, we used FAO's food composition tables (FAO, 2001) for calculating the energy content of traded goods. It is worth mentioning that our analysis only accounts for calorie content of food products and does

[1] Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Saint Kitts and Nevis, St. Lucia, St Vincent and the Grenadines, Suriname, Uruguay, Venezuela. (See http://unstats.un.org/unsd/methods/m49/m49regin.htm)

**Table 1**
Food trade balance for LAC with the rest of the World, volume, value and calories, 1986–2013.
Source: FAO (2016).

| Year | Exports ($10^3$ Tn) | Imports ($10^3$ Tn) | Exports ($10^6$ US$ 2005)[a] | Imports ($10^6$ US$ 2005)[a] | Exports ($10^{12}$ kcal) | Imports ($10^{12}$ kcal) |
|---|---|---|---|---|---|---|
| 1986 | 34,437.5 | 17,465.6 | 20,395.2 | 4122.6 | 103.6 | 62.7 |
| 1991 | 37,593.1 | 19,614.2 | 14,558.9 | 4391.8 | 93.6 | 69.4 |
| 1996 | 40,595.0 | 15,799.5 | 17,109.7 | 4950.9 | 112.5 | 53.4 |
| 2001 | 89,664.5 | 41,442.4 | 32,661.0 | 10,098.6 | 274.1 | 143.2 |
| 2006 | 117,566.2 | 43,880.5 | 48,499.9 | 12,696.8 | 360.1 | 152.2 |
| 2011 | 155,498.6 | 41,708.3 | 62,457.4 | 16,469.0 | 469.4 | 147.2 |
| 2013 | 185,690.9 | 41,872.9 | 65,987.1 | 17,345.8 | 567.7 | 144.2 |

Note: Mexico is absent for 1996 due to lack of data in all tables and figures.
[a] Adjusted to the value added deflator by country for Agriculture, silviculture and fishing (value US$, 2005 prices).

not account for energy required for production as, for instance, found in Arizpe et al. (2011).

In this way, trade indicators (volume, monetary values or calories) for LAC can be expressed as:

$$X \vee M = \sum_{k=1}^{n} p_{\text{kjt}} \tag{1}$$

where:

- $X$ total exports of LAC
- $M$ total imports of LAC
- $p_{kjt}$ exports from country $k$ to country $j$ in year $t$ ($X$); or, imports of country $k$ from country $j$ in year $t$ ($M$), $\forall k \in LAC$ and $\forall j \notin LAC$. Moreover, $p_{\text{jkit}} = \sum_{k=1}^{n} p_{\text{kjt}}$, where $i$ represents the product.

Third, we isolated intra- from inter-regional trade for LAC. The calculations on trade are done considering LAC as a block and in relation to its trade partners, the rest of the world, the US, China and Europe (the continent, as defined by FAOSTAT (FAO, 2016)). This is done by subtracting intra-regional trade from trade data for the aggregate of countries in LAC.

Fourth, using the energy coefficients from FAO's food composition tables (FAO, 2001), we converted trade data (exports and imports) in volume into calories. In order to analyse the Prebish-Singer hypothesis (Prebish, 1950, 1959; Singer, 1950) of the deterioration of the terms of trade in terms of calories, the average calorie content per 100 g reported in the food composition tables was used as proxy for expressing exports and imports in terms of calories, for product $i$ and country $k$ in the year $t$. The food trade balance in calories is expressed as calories exported minus calories imported, as our aim is to show terms of trade in calories that are comparable with standard terms of trade.

Fifth, using USD prices for 2005, that is, adjusted to FAO's value added deflator by country for agriculture, silviculture and fishing, the value of exported and imported calories were used for calculating the unit cost of calories exported and imported, which allowed us to compute the terms of trade in this way

$$\text{ToT}_t = \frac{X_{\text{US\$2005}_t} / X_{\text{kcal}_t}}{M_{\text{US\$2005}_t} / M_{\text{kcal}t}} \tag{2}$$

where ToT stands for terms of trade, $X$ total exports of LAC, $M$ total imports, while *US*$2005 and *kcal* denote the indicators adjusted to constant prices of 2005 and calories, respectively; and $t$, the year.

The interpretation of the terms of trade is the following. A value of 1 means that calories exported have the same cost as calories imported. A value larger than one means positive terms of trade, that is, exported calories are more expensive than imported ones. Therefore, the country needs less calories exported to cover for the cost of its calories imported. A value lower than one means negative terms of trade, the country will be compelled to export larger quantities in order to cover for its imports. As stated before, we do not calculate the actual cost of producing a calorie, but the adjusted price at which that calorie (exported or imported) is traded.

Sixth, an indicator for self-sufficiency in food products for the region was also calculated as one minus the share of imported calories over domestic consumption in terms of calories:

$$\text{Self-sufficiency}_t = \left(1 - \frac{M_{\text{kcal}_t}}{C_{\text{kcal}_t}}\right) * 100 \tag{3}$$

where $C$ denotes domestic consumption of calories.

Seventh, we calculated the level of concentration of products in consumption, measured in kcal, by a cumulative distribution of the relative share in consumption of each of the 74 products reported in the food balances.

## 4. Results

Table 1 presents the food trade balance (for the selected product groups) between LAC and the rest of the world for the period 1986 through 2013. Data is presented in volume, monetary value, and its conversion into calories. Exports in volume increased by 5.4 times their original size in the period, almost the same as in calories (5.5), whereas its monetary value increased by 3.2 times. In the case of imports, they increased by 2.4 times in terms of volume and 2.3 in calories, while they increased by 4.2 times in monetary terms. The surplus has increased fivefold in the period of the 28 years analysed. The region is increasingly feeding the rest of the world.

Food consumption for the selected product groups in LAC is presented in Table 2, in absolute calories content, its share within total

**Table 2**
Food consumption by product group for LAC, measured in kcal, 1961–2011.
Source: FAO (2016).

| | $10^{12}$ kcal/year | | | | | | Share of total consumption (%) | | | | | | Per capita consumption of kcal | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Product groups | 1961 | 1971 | 1981 | 1991 | 2001 | 2011 | 1961 | 1971 | 1981 | 1991 | 2001 | 2011 | 1961 | 1971 | 1981 | 1991 | 2001 | 2011 |
| Cereals - exc beer | 75.5 | 102.2 | 138.6 | 167.0 | 198.7 | 228.6 | 48.8 | 46.7 | 46.3 | 46.2 | 45.7 | 44.8 | 924.8 | 961.9 | 1032 | 1020 | 1029 | 1048 |
| Sugar and syrups | 28.7 | 40.1 | 59.6 | 71.2 | 80.2 | 91.2 | 18.6 | 18.3 | 19.9 | 19.7 | 18.5 | 17.9 | 352.2 | 377.1 | 443.9 | 434.9 | 415.6 | 418 |
| Roots and tubers | 12.8 | 19.4 | 18.6 | 18.8 | 22.1 | 26.0 | 8.3 | 8.8 | 6.2 | 5.2 | 5.1 | 5.1 | 157.1 | 182.2 | 138.3 | 115.1 | 114.3 | 119.4 |
| Pulses | 10.7 | 14.9 | 17.5 | 17.4 | 20.2 | 22.1 | 6.9 | 6.8 | 5.8 | 4.8 | 4.7 | 4.3 | 130.9 | 140.6 | 130.1 | 106 | 104.8 | 101.5 |
| Vegetable oils | 9.1 | 15.5 | 32.0 | 46.5 | 58.1 | 72.7 | 5.9 | 7.1 | 10.7 | 12.9 | 13.4 | 14.3 | 111.7 | 146.3 | 238.1 | 283.8 | 301.3 | 333.5 |
| Fruits - exc wine | 8.9 | 13.8 | 15.5 | 18.7 | 23.7 | 28.9 | 5.8 | 6.3 | 5.2 | 5.2 | 5.4 | 5.7 | 109.0 | 129.4 | 115.6 | 114.5 | 122.7 | 132.4 |
| Alcoholic beverages | 4.2 | 6.1 | 9.1 | 11.5 | 13.8 | 16.9 | 2.7 | 2.8 | 3.1 | 3.2 | 3.2 | 3.3 | 51.8 | 57.7 | 68.12 | 70.49 | 71.42 | 77.58 |
| Vegetables | 2.0 | 2.7 | 3.7 | 4.8 | 7.1 | 8.8 | 1.3 | 1.2 | 1.2 | 1.3 | 1.6 | 1.7 | 24.2 | 25.4 | 27.37 | 29.06 | 36.96 | 40.34 |
| Oil crops | 1.8 | 3.0 | 2.8 | 3.4 | 7.0 | 9.3 | 1.2 | 1.4 | 0.9 | 0.9 | 1.6 | 1.8 | 22.3 | 28.4 | 20.54 | 20.76 | 36.33 | 42.65 |
| Other[a] | 0.8 | 1.3 | 1.8 | 2.1 | 3.7 | 5.4 | 0.5 | 0.6 | 0.6 | 0.6 | 0.8 | 1.1 | 9.8 | 12.4 | 13.1 | 12.63 | 19.11 | 24.92 |
| Total | 154.5 | 219 | 299.2 | 361.4 | 434.6 | 509.9 | 100 | 100 | 100 | 100 | 100 | 100 | 1893.8 | 2061.4 | 2227.13 | 2207.24 | 2251.42 | 2338.29 |

[a] Includes: stimulants, nuts, sugar crops, spices and miscellaneous.

**Table 3**
Composition of exports and imports in food trade measured in kcal by product group, 1986–2011.
Source: FAO (2016).

| Product group | 1986 | | 1991 | | 1996 | | 2001 | | 2006 | | 2011 | | 2013 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % X | % M | % X | % M | % X | % M | % X | % M | % X | % M | % X | % M | % X | % M |
| Sugar and syrups | 42.3 | 1.2 | 13.0 | 4.0 | 23.8 | 0.6 | 23.2 | 1.2 | 24.8 | 2.0 | 23.0 | 2.1 | 22.0 | 2.1 |
| Cereals - exc. Beer | 28.1 | 77.3 | 22.2 | 74.0 | 19.1 | 86.6 | 24.7 | 74.4 | 16.0 | 75.1 | 23.4 | 69.8 | 29.9 | 71.4 |
| Vegetable oils | 14.6 | 9.3 | 24.5 | 8.1 | 25.3 | 4.4 | 17.9 | 5.7 | 21.9 | 4.9 | 12.6 | 9.9 | 9.3 | 8.7 |
| Fruits - exc. Wine | 3.5 | 0.1 | 8.1 | 0.2 | 7.7 | 0.3 | 3.4 | 0.3 | 3.5 | 0.3 | 2.8 | 0.4 | 2.5 | 0.4 |
| Oil crops | 8.3 | 9.6 | 27.2 | 11.5 | 21.3 | 4.9 | 28.4 | 15.0 | 31.5 | 14.6 | 36.2 | 14.2 | 34.6 | 12.9 |
| Stimulants | 1.7 | 0.0 | 2.6 | 0.2 | 1.6 | 0.2 | 0.7 | 0.3 | 0.8 | 0.5 | 0.7 | 0.5 | 0.6 | 0.5 |
| Pulses | 0.5 | 1.7 | 0.7 | 1.1 | 0.2 | 1.6 | 0.4 | 1.9 | 0.4 | 1.3 | 0.3 | 1.5 | 0.2 | 2.0 |
| Vegetables | 0.3 | 0.1 | 0.6 | 0.1 | 0.2 | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.3 | 0.5 |
| Alcoholic beverages | 0.3 | 0.3 | 0.6 | 0.4 | 0.4 | 0.7 | 0.6 | 0.3 | 0.6 | 0.3 | 0.5 | 0.4 | 0.5 | 0.5 |
| Other[a] | 0.3 | 0.2 | 0.3 | 0.2 | 0.4 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.2 | 0.4 | 0.2 | 0.5 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

[a] Includes: spices, nuts, roots and tubers and miscellaneous.

consumption and calories per capita. The main result observed here is the notable increase in the consumption of vegetable oil, which, in per capita terms, is 3 times higher at the end of the period, while there is a reduction in pulses and roots and tubers. Sugars also increase over time, representing around 20% of the calorie intake, well above the WHO *strong recommendation* of reducing the intake of free sugars to less than 10% of total energy intake (World Health Organization, 2015).

The relative share of exports and imports in terms of calories by product group is presented in Table 3. The region has reduced its exports of sugar and syrups, which went from representing 42.3% in 1986 to 22.0% in 2013. Cereals still represent almost 30% of total exports. On the other hand, vegetable oil has slightly decreased its share. The biggest rise is in oil crops, which went up from 8.3% to 34.6%, basically from soybean production in the south. The region does not only consume more vegetable oil as we saw above, but it exports increasing quantities of oil seeds. With regard to imports, the region is very dependent on cereals, representing more than 70% of total imports in the period.

The main five products exported by the region in the year 2013 were soy (34.1%), corn (24.7%), sugar (21.4%), soybean oil (7.6%) and wheat (1.8%). Interestingly, some of the main five products imported by the region correspond to products that the region is also exporting, wheat (37%), corn (25.2%), and soy (7.4%).

This overall result hides differential behaviours dependent on the trade partner analysed. In year 2013 the main trade partners for LAC countries were China, Europe and the USA. The corresponding market share for LAC exports was 28%, 12.8% and 6.5% respectively, that is, 47.3% between the three of them. Imports from LAC countries are far more concentrated, with the USA representing 71.3% in the same year. Based on this, we decided to analyse these cases individually.

Thus, in Fig. 1 we can see how the region maintains a negative food balance with the USA, which has doubled in the period and corresponds, in a large part, to cereals, with a maximum in year 2007. In 2013 wheat represented 35.6% of imports and corn 34.1%, while the region exported mainly sugar (32.8%), corn (17.3%) and banana (6.7%).

When analysing the trade relationship with China, Fig. 2, the region maintains a positive and growing balance, which in 2013 reached a value almost three times higher than the deficit reported with the USA. The relationship with China seems not to have suffered the boom and bust of commodities in recent years. Most of the exports to China are soy (83.6%), sugar (9.1%) and soybean oil (6.3%), while the scarce imports from China consisted basically of beans (56.9%).

In the case of trade with Europe, Fig. 3 shows how the region maintained a positive balance during the period, reaching a maximum in 2007. The balance fell abruptly in 2009 when values similar to those in 2000 were attained. Exports to Europe in the year 2013 were dominated by soy (40.3%), sugar (18.7%), corn (12.6%), banana (4.7%) and palm oil (4%), while the small amount of imports from Europe were led by barley (32.6%), wheat (29.2%), olive oil (10%) and alcoholic beverages (5.7%). Clearly, these differences between exported and imported products will be important to understand the terms of trade expressed in calories that are discussed below.

Deepening the data analysis shown in Table 1, Fig. 4 presents the cost of one million kcal exported and imported in real terms (left axis) and the ratio between the cost of the exported calorie and the imported

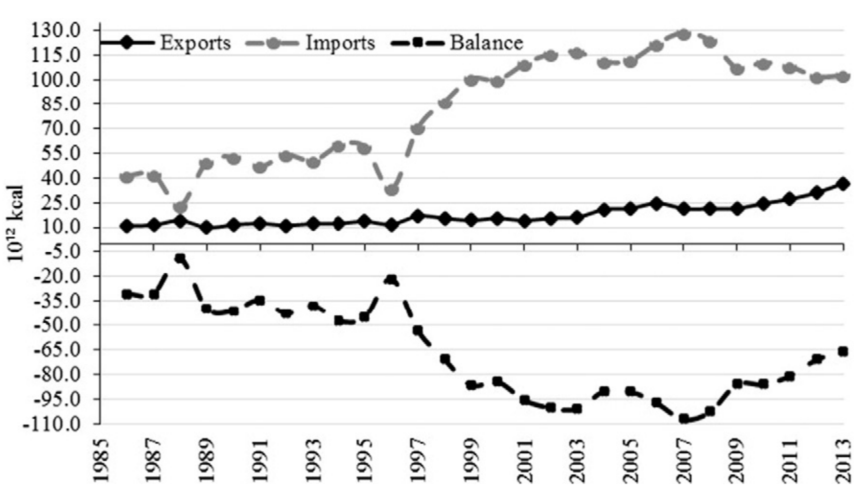


**Fig. 1.** LAC exports, imports and trade balance for food products with the USA ($10^{12}$ kcal), 1986–2013.
Source: FAO (2016).

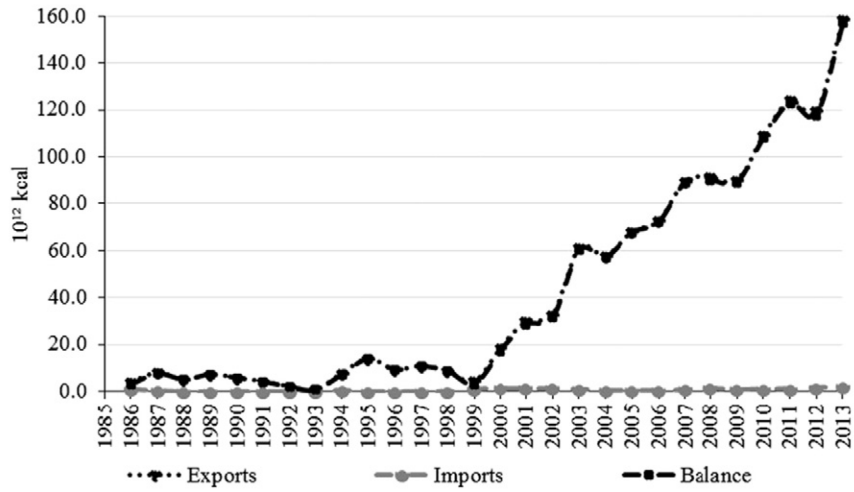


**Fig. 2.** LAC exports, imports and trade balance for food products with China ($10^{12}$ kcal), 1986–2013.
Source: FAO (2016).

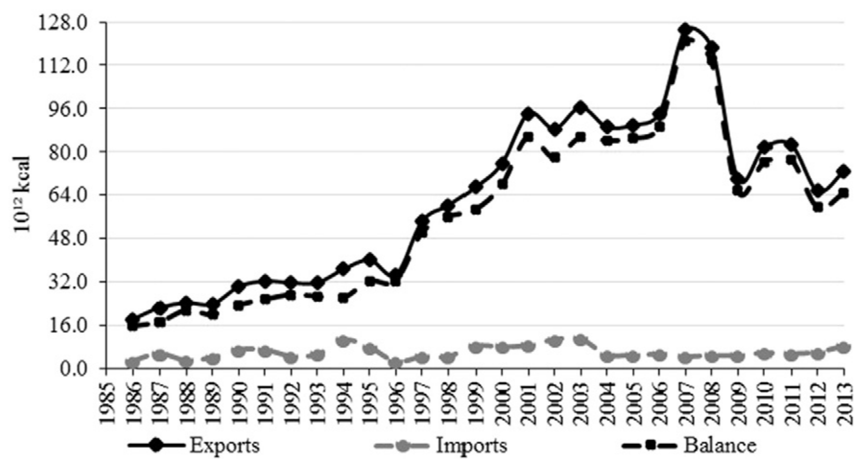


**Fig. 3.** LAC exports, imports and trade balance for food products with Europe ($10^{12}$ kcal), 1986–2013 .
Source: FAO (2016).

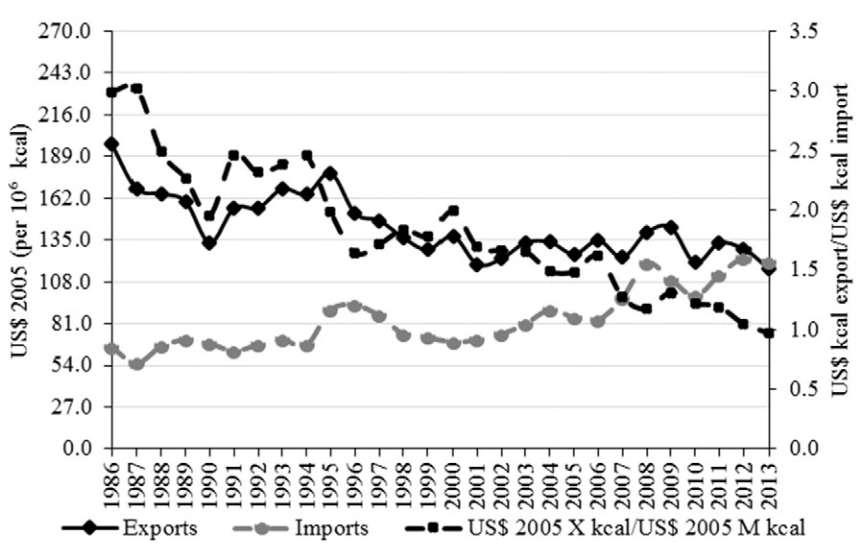


**Fig. 4.** LAC exports, imports and terms of trade, 1986–2013.
Source: FAO (2016).

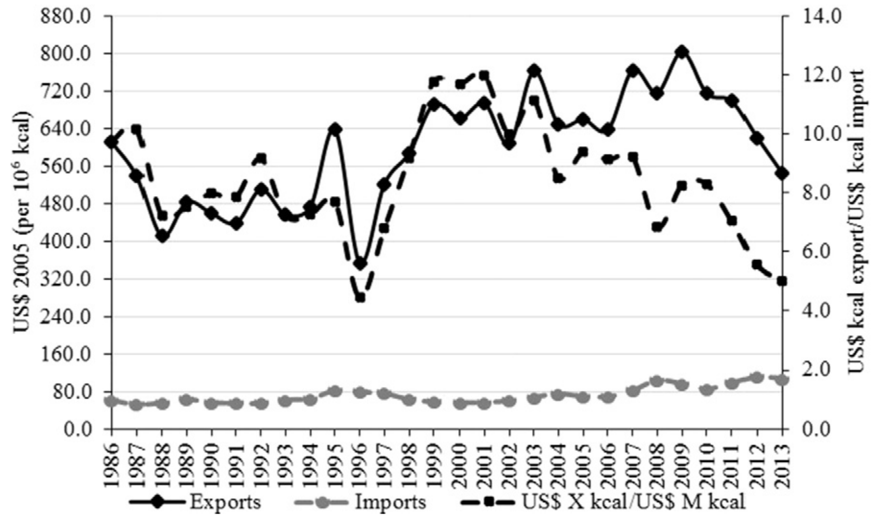


**Fig. 5.** LAC exports, imports and terms of trade with the USA, 1986–2013.
Source: FAO (2016).

calorie (right axis), that is, an approximation of the terms of trade measured in calories. The trend observed in the figure is a reduction in the cost of exported calories and a slight increase in the cost of imported calories over time, which implies a deterioration of the terms of trade measured in calories, with a decrease of more than 200% in the period analysed. Thus, the region is not only increasingly feeding the rest of the world (Table 1), but it does so at a lower cost over time, despite the recent boom in food prices experienced worldwide.

Again, this result differs depending on the trading partner. Terms of trade are very favourable to LAC with respect to the USA, as seen in Fig. 5, exporting expensive calories (sugar, syrups, banana) and importing cheap ones (corn, wheat). Nevertheless, since year 2001 they tend to worsen over time.

In the case of China, Fig. 6 shows how imported calories (beans) are more expensive than exported ones (soy) for almost all years in the period, showing also a deterioration of terms of trade over time.

Finally, Fig. 7 shows how the terms of trade experienced a drastic change with Europe in 1996. Before that year, calories exported by LAC countries to Europe were more expensive than those imported. However, after that year, the trend reversed and calories imported (olive oil, alcoholic beverages) became increasingly more expensive and calories exported (sugar, soy) became cheaper, deepening the worsening of terms of trade, which deteriorated more than 300% in the period.

Table 4 presents data on self-sufficiency for the region, measured as 1 – (imports/consumption). If a country has zero imports, the index would equal to 1, implying the country is 100% self-sufficient. If a country has a level of imports larger than domestic consumption, the value of the index is negative. If a country, on the other hand, covers half of its domestic consumption with imports, the index would equal 0.5 (or 50%), meaning self-sufficiency is only of 50%. Despite being a net exporter region for most of the product groups, LAC also depends on imports from countries outside the region. The dependency on oil crops is attributable in more than 90% to the case of Mexico. In aggregated terms, the region shows a loss of self-sufficiency, notably due to cereals. Paradoxically, many of the products that are imported are, at the same time, exported to the rest of the world, showing a lack of complementarity

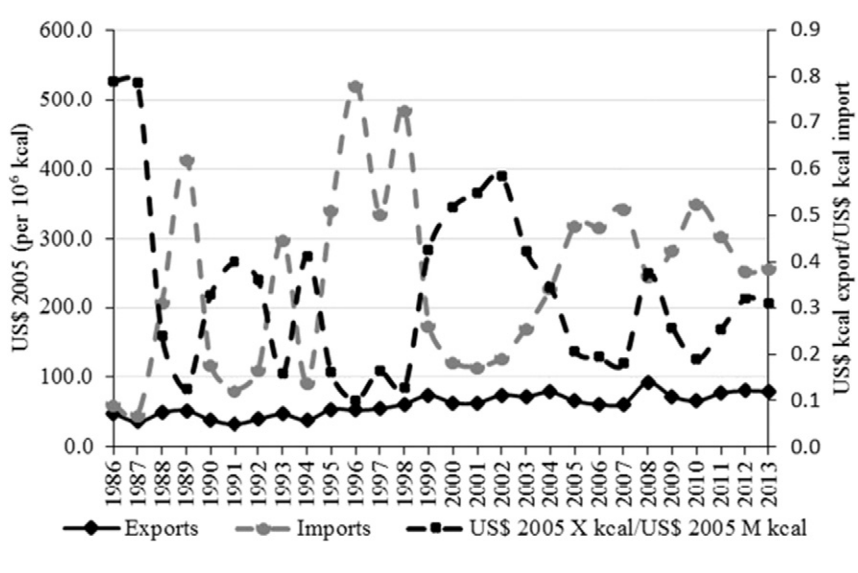


**Fig. 6.** LAC exports, imports and terms of trade with China, 1986–2011.
Source: FAO (2016).

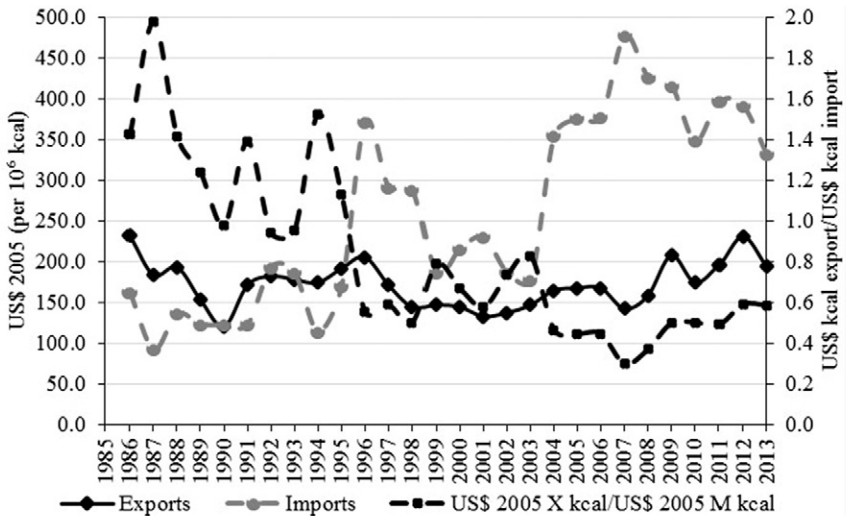


**Fig. 7.** LAC exports, imports and terms of trade with Europe, 1986–2013.
Source: FAO (2016).

in regional food trade. In particular, Argentina exports cereals to the rest of the world, while most of the countries are importing cereals from the rest of the world. This is also the case for sugar and syrups.

Finally, our research shows (see Table 5) the degree of concentration of consumption of a few products, measured in kcal, comparing 1961 and 2011. This high concentration of a these products did not change much in the period. Only ten products represented 80.5% of calorie intake in 2011. The major changes found are the reduction in importance of beans, cassava and potatoes, the rise of soy bean, oil and palm oil, the increase in importance of beer, and the disappearance of bananas from the top ten products. Apart from the change in the diet, a large fraction of consumption is still concentrated on a very small number of products. Trade has made more food available at the same time, it has encouraged homogenisation (Kennedy et al., 2004; Ogundari and Ito, 2015).

## 5. Discussion

As shown by Fig. 4, the region as a whole has experienced favourable terms of trade during the period analysed, with the exported calorie being more expensive than the imported calorie. However, this result, apart from being different depending on the trading partner (see Figs. 5-7), is deteriorating over time, leading us to conclude that there is a worsening of the terms of trade in caloric terms.

If we put together the fact that trade balance is increasingly positive in volume terms with the deterioration of terms of trade, we can say that LAC countries tend to be exporting ever cheaper food products to the rest of the world, making the diet elsewhere more affordable. Considering the environmental consequences of some food products adds another perspective that is often neglected. First, the products most

**Table 4**
Food self-sufficiency index for LAC in kcal, $(100 * (1 - (imports / consumption)))$, 1986–2011.
Source: FAO (2016).

| Year | Aggregate | Cereals – exc. beer | Oil crops | Vegetable oils | Sugar & syrups | Pulses | Alcoholic beverages | Stimulants | Vegetables | Roots and tubers | Fruits – exc. wine | Nuts | Spices | Miscellaneous |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1986 | 81.0 | 68.5 | −135.2 | 85.3 | 98.9 | 93.1 | 98.2 | 96.8 | 98.9 | 99.2 | 99.6 | 91.2 | 82.8 | 30.7 |
| 1987 | 80.1 | 67.6 | −264.5 | 88.2 | 98.7 | 95.8 | 98.4 | 98.1 | 99.1 | 99.5 | 99.6 | 93.5 | 85.0 | 32.4 |
| 1988 | 91.0 | 84.2 | 20.3 | 96.0 | 98.5 | 96.4 | 99.0 | 98.6 | 99.6 | 99.7 | 99.8 | 97.2 | 90.0 | 84.0 |
| 1989 | 83.4 | 74.1 | −99.4 | 88.7 | 96.4 | 94.8 | 90.2 | 91.6 | 99.2 | 99.6 | 99.6 | 89.5 | 92.0 | 86.2 |
| 1990 | 81.0 | 70.2 | −75.9 | 87.2 | 93.5 | 90.3 | 95.7 | 86.5 | 98.5 | 99.2 | 99.4 | 91.6 | 88.3 | 79.0 |
| 1991 | 80.8 | 69.3 | −134.5 | 88.0 | 96.2 | 95.5 | 97.4 | 85.9 | 98.4 | 99.1 | 99.3 | 86.9 | 84.4 | 73.6 |
| 1992 | 80.0 | 67.4 | −192.3 | 89.2 | 98.8 | 95.1 | 96.8 | 83.9 | 98.2 | 98.9 | 99.3 | 84.7 | 88.5 | 40.2 |
| 1993 | 79.4 | 67.0 | −226.2 | 87.3 | 98.9 | 96.3 | 96.7 | 84.2 | 96.9 | 98.6 | 98.9 | 81.8 | 85.1 | 41.0 |
| 1994 | 74.4 | 58.5 | −245.9 | 86.4 | 97.9 | 93.3 | 96.0 | 79.7 | 96.7 | 99.1 | 98.3 | 73.8 | 82.4 | 53.8 |
| 1995 | 77.7 | 64.2 | −219.6 | 85.8 | 98.7 | 94.7 | 97.3 | 79.5 | 96.8 | 99.1 | 98.7 | 83.3 | 82.0 | 63.1 |
| 1996 | 86.5 | 74.4 | 44.1 | 95.1 | 99.6 | 95.8 | 97.1 | 90.3 | 97.5 | 99.5 | 99.3 | 92.5 | 86.0 | 69.0 |
| 1997 | 75.6 | 64.3 | −286.7 | 85.8 | 98.7 | 91.7 | 96.4 | 75.7 | 95.8 | 99.0 | 98.5 | 80.8 | 82.0 | 58.4 |
| 1998 | 72.2 | 56.5 | −226.1 | 84.1 | 99.0 | 88.5 | 96.8 | 75.2 | 95.7 | 98.7 | 98.6 | 82.5 | 78.5 | 53.2 |
| 1999 | 68.3 | 47.8 | −194.8 | 86.1 | 98.9 | 87.2 | 97.7 | 59.2 | 96.0 | 98.7 | 98.5 | 77.7 | 85.0 | 46.6 |
| 2000 | 68.5 | 48.6 | −197.0 | 85.0 | 98.5 | 89.3 | 96.9 | 57.4 | 95.7 | 98.6 | 98.2 | 69.2 | 87.1 | 46.8 |
| 2001 | 67.0 | 46.3 | −206.7 | 85.8 | 97.9 | 86.6 | 96.4 | 70.6 | 95.7 | 98.7 | 98.1 | 68.3 | 86.0 | 34.2 |
| 2002 | 66.8 | 45.8 | −188.9 | 84.4 | 98.6 | 89.5 | 96.8 | 60.8 | 95.5 | 98.8 | 98.6 | 69.6 | 86.1 | 50.3 |
| 2003 | 67.8 | 47.1 | −155.1 | 85.9 | 98.5 | 89.4 | 97.2 | 59.6 | 95.7 | 98.2 | 98.6 | 69.5 | 87.1 | 56.5 |
| 2004 | 69.5 | 49.4 | −115.8 | 86.2 | 98.1 | 88.7 | 97.0 | 66.4 | 95.3 | 97.5 | 98.7 | 66.4 | 86.8 | 64.9 |
| 2005 | 68.5 | 49.0 | −151.3 | 86.8 | 97.5 | 88.1 | 96.6 | 60.8 | 94.2 | 98.5 | 98.3 | 70.5 | 90.0 | 61.3 |
| 2006 | 67.9 | 47.4 | −172.7 | 88.3 | 96.5 | 91.2 | 96.4 | 51.4 | 93.8 | 98.3 | 98.3 | 63.7 | 89.1 | 52.8 |
| 2007 | 65.2 | 42.1 | −157.4 | 86.7 | 95.5 | 87.7 | 96.1 | 37.8 | 94.0 | 98.2 | 98.2 | 67.2 | 88.4 | 65.0 |
| 2008 | 69.0 | 49.6 | −133.9 | 84.1 | 97.0 | 90.4 | 96.6 | 46.5 | 93.1 | 98.3 | 98.2 | 69.0 | 89.3 | 74.5 |
| 2009 | 72.1 | 55.3 | −137.7 | 84.7 | 97.5 | 90.5 | 96.1 | 46.4 | 93.5 | 98.1 | 98.4 | 74.5 | 89.5 | 72.5 |
| 2010 | 70.8 | 54.8 | −155.9 | 81.0 | 96.6 | 89.9 | 96.5 | 53.5 | 93.1 | 97.8 | 98.1 | 71.4 | 88.4 | 77.9 |
| 2011 | 71.1 | 55.0 | −125.1 | 80.1 | 96.7 | 89.9 | 96.2 | 55.3 | 93.3 | 98.0 | 98.0 | 70.8 | 89.3 | 77.7 |

**Table 5**
Cumulated share of products in consumption, in kcal, 1961 and 2011.
Source: FAO (2016).

| Ranking | Main products in 1961 | % cumulated 1961 | % cumulated 2011 | Main products in 2011 |
|---|---|---|---|---|
| 1 | Corn and products | 19.7 | 16.8 | Corn and products |
| 2 | Wheat and products | 36.9 | 33.0 | Wheat and products |
| 3 | Sugar (raw equivalent) | 52.0 | 48.3 | Sugar (raw equivalent) |
| 4 | Rice (milled equivalent) | 62.8 | 59.3 | Rice (milled equivalent) |
| 5 | Beans | 68.7 | 67.6 | Soybean oil |
| 6 | Cassava and products | 73.2 | 71.2 | Beans |
| 7 | Sugar non-centrifugal | 76.5 | 74.0 | Palm oil |
| 8 | Potatoes and products | 79.0 | 76.4 | Cassava and products |
| 9 | Bananas | 81.1 | 78.5 | Beer |
| 10 | Cottonseed oil | 82.9 | 80.5 | Potatoes and products |

exported, sugar and syrups, cereals and oil crops, correspond largely to monocultures. These three categories alone accounted for 86.5% of the calories exported by the region in 2013 (see Table 3), showing how trading patterns affect production, by pushing monocultures, which have environmental impacts attached to them (Altieri, 2009; Gomiero et al., 2011; Tilman, 1999) and use large amounts of inputs (Arizpe et al., 2011, 2014). Second, loss of soil and soil nutrients discussed by Walter Pengue (2005) for soy exports in Argentina and Grote et al. (2005) for global trade flows. Third, growing research also shows, an increase in water use from monocultures and the virtual water trade embodied in agricultural products (Aldaya et al., 2010; Duarte et al., 2014; de Fraiture et al., 2008; Giampietro et al., 2014; Hoekstra and Hung, 2005; Pérez-Rincón, 2006b, 2007; Sposito, 2013).

We have also observed that the region faces a loss in food self-sufficiency, as was shown in Table 4. This is to say that the region is increasingly feeding the world at the same time it is losing self-sufficiency in certain products (e.g. cereals, vegetables, pulses, stimulants, nuts), which makes it more vulnerable to international prices, control over seeds and other external factors. The loss in self-sufficiency in cereals may bend to pressures from the external market, by means of bilateral and multilateral trade agreements as shown in Falconi and Oleas-Montalvo (2016). As we saw in Table 3, cereals represented 29.9% of exports from the region in 2013, at the same time that the region is increasingly importing cereals from elsewhere representing 45% of consumption in 2011, as seen in Table 4. This change in production patterns implies a loss of soil and nutrients in the region. If we add the increased use of water, fertilizers and energy, this may be leading to higher environmental impacts.

The change in the consumption pattern observed in Table 2 has implied a drastic increase in fats, precisely one of the products the region has started to export increasingly. Our hypothesis is that this change in consumption has been preceded by a change in production trends, itself a reaction to food trade patterns. We leave for future research the examination of the validity of this hypothesis.

Our research has, at least, two limitations. First, we have analysed only calorie intake, without distinguishing the quality of the calories taken. Future research should expand the analysis and split calories into macro- and micro-nutrients to be able to link caloric unequal exchange to nutritional status. Second, we have focused on the cost of the calorie traded, and we have not accounted for the cost of the calorie produced. Again, future research should deepen the analysis to account for this.

## 6. Conclusions

This research has contributed to the debate on unequal exchanges, by enlarging the topic with the newly coined term of caloric unequal exchange.

The study concludes that although calories exported by the region to the rest of the world are more expensive than those imported, the ratio is deteriorating over time. This trend is found to be dependent of the trading partner involved. The region is helping the rest of the world in supplying their diets at a lower cost. A side result is that globalisation is homogenising diets over time, concentrating most food consumption in a reduced number of products, and therefore increasing interdependency among countries and affecting food security. There is a loss in self-sufficiency in the region that seems to be linked to trade patterns, that is, production is not focused on domestic demand, but on exports. Unequal caloric exchange is deepening regional dependency, deteriorating the trade balance over time and shifting the diet towards lower-quality products.

We have found that there is a deterioration of the terms of trade of food in terms of calories for the region, of more than 200% between 1986 and 2013. This is in conjunction with an increased volume (and value) of exports, which increased by a factor of 5.4 (and 3.2). This boom in commodity exports results in increasing environmental costs in terms of water use, soil deterioration, export of nutrients, and increased energy consumption and $CO_2$ emissions for those exports, which fall under the category of ecologically unequal exchange.

A side result of this study, is that there exists a homogenisation of diets; that is, a concentration of consumption of just a few products, which are, effectively, the most traded around the world. In fact, in year 2011 only 3 products (corn, wheat and sugar) accounted for almost 50% of calorie consumption, while 10 products accounted for more than 80%. This entails an ever greater interdependency among countries that increases economic vulnerability and entails a threat for the region's food self-sufficiency. In a context of rising prices of energy inputs and commodities, as well as negative trade balances, and increasing royalties paid to large companies controlling seeds, as in the case of many Latin American countries, reaching food self-sufficiency becomes a political goal in itself. It prevents the countries from increasing vulnerability to international prices and other external factors, as the European Union has done (Candel et al., 2014; Guinea, 2013).

From a nutritional point of view the concentration of consumption also has implications. We observed how consumption of oils and fats grew faster than that of other products, while others decreased, such as cereals, pulses, and roots and tubers. Further research is needed to test the relationship between trade patterns and consumption, and isolate them from demographic factors (as different demographic population structures are associated with different food requirements) and income issues (food intake composition also changes with increasing income levels), which are both demand-side.

The results outlined here suggest that food trade negotiations by Latin America and the Caribbean countries within the WTO would benefit from including the unequal exchange discourse, both ecological and caloric. The recognition of these hidden costs would not be the only advantage, but also the full understanding of the determinants of dietary changes, usually explained by demand-side variables only.

Even if caloric unequal exchange opens new options for understanding international trade, production structures and its impact on consumption, this concept is not a substitute for studying existing power relationships in trade as well as using complementary approaches that involve monetary and biophysical issues, such as physical trade balances within material flow accounting. In fact, unequal caloric exchange occurs precisely because there are political asymmetries between trade partners. Here, the contribution of the structuralist and dependency theory schools in the region is crucial, as they question the fact that trade brings benefits to all parties. There are winners and losers, and the deterioration of terms of trade imposes major efforts on exporting countries in terms of exploitation of soil and natural resources. This is the main conclusion reached by those studying ecologically unequal exchange. The concept of caloric unequal exchange widens this interpretation and shows how there is also an unjust exchange in terms of calories.

## Acknowledgements

The authors would like to thank three anonymous referees for their comments. We also thank Kaysara Khatun, Roldan Muradian and Tiziano Gomiero for a review of an earlier version of the paper. Jesus Ramos-Martin acknowledges the Project HAR2013-47182-C2-1-P from the Spanish Ministry of Science and Innovation. This project has been funded by the ACCD, the Catalan cooperation agency.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.ecolecon.2017.01.009.

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