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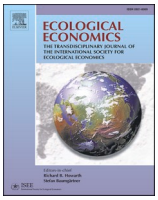

# Extractivism, ecologically unequal exchange and environmental impact in South America: A study using Material Flow Analysis (1990–2017)

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ABSTRACT

With the economic and trade liberalisation policies of the late 20th century, the extraction of natural resources for export, known as extractivism, became the central axis of South American economies. This development model has a significant environmental impact and has generated imbalances in the South American productive structure that lead to chronically unfavourable terms of trade for the region. The different price dynamics of exports and imports trap South America in a vicious circle that leads to a progressive need to increase the volume of resources it extracts. Consequently, South America maintains a situation of ecologically unequal exchange that implies the absorption of an ever-increasing environmental impact from the rest of the world. All this calls into question the benefits of free trade, especially in ecological terms, as well as the compatibility between economic growth and the reduction of environmental impact.

## 1. Introduction

In the last decades of the 20th century, policies derived from the Washington Consensus led to the introduction of neoliberal policies in South America, resulting in deep financial and trade liberalisation (Slipak, 2014; Svampa, 2012). Consequently, there was a reprimarisation of the economic structure, prioritising the extraction of natural resources and favouring the presence of multinational companies capable of undertaking the necessary investments (Acosta, 2013; Gudynas, 2011). In traditional extractivism, states assume a marginal role, guaranteeing multinational companies the appropriate conditions for the exploitation of natural resources so that the economic growth derived from these activities generates a spill-over effect on the rest of the economy, favouring the development of other sectors and the improvement of social conditions (Gudynas, 2011; Portillo, 2014). Extractivism is thus the result of neoclassical free trade policies, so that extractivist countries would specialise in the production of those commodities for which they have comparative advantages and ecological externalities are internalised in prices (Lindert, 1990; Muradian and Martinez-Alier, 2001; Repetto, 1994; Villafañe, 2012). This is closely linked to Environmental Kuznets Curve (EKC) theories, which argues that the relationship between growth and ecological impact follows an inverted U-shape, so that the damage caused in the early stages of development will be compensated by the surplus obtained in the later stages of development (Panayotou, 1995).

The limited social progress achieved by these policies, together with an ideological shift in government in most South American countries, lays the foundations for what is known as neoextractivism. This form of extractivism differs from traditional extractivism mainly in the much more active role of the state, either through increased regulation and taxation, or through state exploitation of resources (Portillo, 2014). In this case, it is believed that extractivist activity would increase state resources and allow the state to manage the development of new economic sectors and improve social conditions.

Favourable commodity export prices for much of the last two decades have reinforced the strategy of development through natural resource extraction, resulting in the commodification of many of South America's economies (Baletti, 2014; Collard and Dempsey, 2013; Portillo, 2014; Svampa, 2019). In fact, the characteristic policy lines of neoextractivism are grouped into what is commonly referred to as the Commodity Consensus (Svampa, 2013). Commodification led to the expansion of agro-industry, characterised by the dominance of large-scale monocultures (Baletti, 2014; Gudynas, 2009; Svampa, 2012). Thus, the environmental impact and dependence on extraction is not only maintained, but also extended to other sectors and resources (Gudynas, 2009, 2011).

In the context of neoextractivism, it is important to note the increase in Chinese investments in South America, generally oriented towards

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companies operating in sectors with a high ecological impact (Brand et al., 2016; Gallagher et al., 2012). The favourable commodity price development is closely linked to the large increase in Chinese demand in the first decade of the 2000s (Jaramillo et al., 2009; Roache, 2012). This led to a significant increase in the dependence of South American countries on Chinese trade and investment, to the detriment of those coming mainly from the USA (Svampa, 2012). However, trade remains unequal, with South America exporting raw materials to China and importing manufactured goods, reinforcing the region's extractivism, to the extent that it is common for China to maintain a strategy of loans payable in oil with certain countries (Villafañe, 2012). At the same time, the material diversification that characterises neoextractivism is closely linked to China, given its high demand for agricultural commodities such as soya (Gudynas, 2011; Roache, 2012). In ecological terms, the differences between extractivism and neoextractivism are more of form than substance. Through free trade, this form of economic organization maintains the ecological inequalities that have existed since colonial times (Røpke, 2001). Therefore, in this article the word extractivism is used to refer to both traditional extractivism and neoextractivism.

Ecological Economics criticises the constant omission of the impact on the environment when referring to the benefits of free trade (Goodland and Daly, 1993; Hornborg, 1998; Muradian and Martinez-Alier, 2001). High ecological impact activities continue to be the driving force of the South American economy, and important ecological inequalities in foreign trade remain. The theory of Ecologically Unequal Exchange (EUE) is concerned with the analysis of these inequalities, indicating that there is a constant transfer of resources to developed countries from less developed countries, which also limits the development possibilities of these countries (Røpke, 2001).

This article aims to analyse the effects of extractivism and ecologically unequal trade on environmental impact in South America. The main novelty and contribution of this research comes from the analysis of EUE and environmental impact using the territorial and consumption approaches, what makes it possible to study the differences between the local impact and the impact that is associated with the final consumption of a territory, making possible to verify the environmental burden shifted or assumed by a country. The use of the consumption approach and the Material Footprint to analyse the EUE is not yet widespread, so the use of this methodology is another of the novelties of this article. The consumption method allows for better approximations of the EUE, thus complementing the information on environmental impact provided by the territorial approach, leading to more complete conclusions about the evolution of environmental impact and the responsibility of each territory for it. Moreover, the relationship between economic growth and material consumption is also analysed for South America and for the countries chosen to establish comparisons that add context to the South American situation, which are China, the USA, and the EU-15. Therefore, it is possible draw stronger conclusions about the relationship between economic growth and material consumption.

## 2. Methods and Data

The data in this paper are mainly from the Global Material Flows Database of the United Nations Environment Programme International Resource Panel (2018). These data are complemented by World Bank data from the World Development Indicators Database, from which USD 2010 GDP and total population are extracted, and from the World Trade Organization, from which the trade data in monetary terms are obtained.

South America[1] was chosen because it is made up of a group of countries that have many characteristics in common, especially their extractivist economic structure. The similar characteristics of these countries mean that they are usually studied as a group, as in Belloni and Peinado (2013), Cardoso and Holland (2010), Dittrich and Bringezu (2010) or Samaniego et al. (2017). To contextualise the situation in South America, it is considered appropriate to use comparisons with the USA, China, and the EU-15.[2] In the case of the USA, it is the most important economy of the 20th century and maintains an important trade relationship with South America. It is also the country that generates the greatest environmental impact and one of the most influential in international trade. China is a very different economy from the USA which, in recent decades, has acquired great relevance in international trade, both as an exporter of goods and as an importer of commodities (Jaramillo et al., 2009; Pérez Lagüela, 2017; Roache, 2012; Xun, 2018). In addition, as discussed above, it has greatly expanded its influence in South America, through trade and financial relations (Gallagher et al., 2012; Jaramillo et al., 2009; Roache, 2012). Finally, the EU-15 represents a group of highly developed countries whose economies have been progressively de-industrialised in recent decades in favour of the service sector (Serrenho et al., 2014). With limited resource endowments, they are highly dependent on the rest of the world for their material needs, both in terms of raw materials and, increasingly, industrial production (Weisz et al., 2006).

### 2.1. Material Flows Analysis

Material Flows Analysis (MFA) is a method developed by Ayres and Kneese (1969) in the context of the study of economic externalities, subsequently updated and improved in a process that continues today (Ayres and Ayres, 1998; Daniels, 2002; Daniels and Moore, 2001; EUROSTAT, 2018; Fischer-Kowalski et al., 2011; Fischer-Kowalski and Haberl, 1998). Based on the theories of socio-economic metabolism, the MFA measures the material flows generated by the socio-economic activity of a territory, providing the accounting of material flows (Ayres and Simonis, 1994; Fischer-Kowalski and Weisz, 1999). The importance of material flows is that they are the physical link between societies and nature, providing information about the pressure exerted by human activities on the environment (Eisenmenger et al., 2016). The MFA approach is based on the degradation inherent in the use of nature's resources, according to the Laws of Thermodynamics (Georgescu-Roegen, 1996), as well as nature's limited capacity to assimilate waste (Carpintero, 2003; Fischer-Kowalski and Haberl, 1998). There are different methods for accounting material flows and assigning responsibility for the ecological or environmental impact to each territory. In this paper, the two most widespread methods, the territorial or production method and the consumption method, are used to analyse the differences between the two approaches.

In the territorial approach, the materials used in domestic production processes are counted for each territory, deducting the weight of exported goods and adding the weight of imported goods (EUROSTAT, 2018; Krausmann et al., 2017; Piñero et al., 2019; Schandl et al., 2016, 2018). Using this method, material flows correspond directly to monetary flows (Schaffartzik et al., 2015), providing an approximation of the environmental impact that occurs within the studied territory. On the other hand, the consumption approach assigns to each territory the consumption of the materials used to produce the goods consumed by its final demand, whether or not they are part of the final traded good and regardless of where the production takes place (Arto et al., 2012; Dittrich et al., 2012a; Schandl et al., 2018). This method requires the estimation of the part of the trade flows that do not correspond to the weight of the final good, known as Indirect Trade Flows (ITF), for which raw materials equivalents (RME) are sought in terms of the domestic

[1] South America includes the following countries: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru and Uruguay.

[2] All the countries that were part of the European Union in 2004: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

extraction of each territory (Dittrich et al., 2012a; Schandl et al., 2018; Wiedmann et al., 2015).

### 2.2. Ecologically Unequal Exchange and Terms of Trade

The EUE has its origins in the addition of an ecological perspective to theories that study dependency and unequal exchange between rich and poor countries as the cause of the latter's development problems, including Prebisch (1950), Wallerstein (2011) and Emmanuel (1972). Asymmetrical relations between these groups of countries led to the less developed ones supporting the activity of the more developed ones with their own natural resources, resulting in an unequal exchange that compromises their sustainability, while limiting their capacity for development (Bunker, 1984) and generates a major irreversible ecological impact. From a more contemporary ecological economics perspective, EUE can be defined as a constant flow of resources from less developed to more developed countries, which implies the transfer of environmental impacts to the latter and negatively affects their development capacity (Hornborg, 1998; Pérez-Rincón, 2006; Røpke, 2001).

The theory of EUE is very close to that of Environmental Load Displacement, which refers to the process by the more developed countries outsourcing their high environmental impact industries and activities to less developed countries, through trade, foreign direct investment, and global value chains (Givens and Huang, 2021; Muradian et al., 2002).

The origin of the EUE is generally placed in the colonial period (Infante-Amate and Krausmann, 2019; Røpke, 2001), but its continuity and the rise of extractivism in recent decades cannot be understood without free trade. From the perspective of EUE theory, free trade operates as a zero-sum game, in which countries specialized in extractive activities, with low value added and high ecological impact, lose out to rich countries specialized in high value added activities with low ecological impact (Dorninger and Eisenmenger, 2016; Pérez-Rincón et al., 2018; Piñero et al., 2020). Differences between the value added of exported and imported goods mean that the cost of each kilo of imports is much higher than the gain from each kilo of exports, which can be measured through the Terms of Trade (TOT), the ratio between the monetary value of each kilo of exported and imported goods (Infante-Amate and Krausmann, 2019; Samaniego et al., 2017). The TOT are of great importance to understand the logic of extractivist economies, as it is the difference between the prices of raw materials and factors of production that allows rich countries to appropriate the resources of poor countries and reallocate their environmental burden (Muñoz et al., 2011). This paper uses TOT calculated from monetary trade flows of goods and physical trade flows, both direct and commodity equivalent, according to the following equation:

$$TOT^{3} = (X_{kg} / X_{\$}) / (M_{kg} / M_{\$}) \quad (1)$$

Where X are Exports and M are Imports.

When TOTs evolve unfavourably, they puts significant pressure on natural resource extraction to offset the price of imports, generating greater environmental pressures (Samaniego et al., 2017), which in turn lead to an increasing number of socio-ecological conflicts in exporting countries (Martínez-Alier, 2004; Martinez-Alier and Walter, 2016; Wilkinson, 2011).

In extractivist countries, the EUE is easily observable through the asymmetries that exist in the flow of resources that they maintain with more developed countries (Belloni and Peinado, 2013; Peinado, 2015; Pérez-Rincón et al., 2018). Trade inequalities allow more developed countries to externalise some of their environmental impacts to other parts of the world (Jorgenson, 2016), polarising the distribution of global environmental impact. (Muradian and Martinez-Alier, 2001).

The ecological economics provides a wide range of indicators to study the EUE. However, due to its simplicity and ease of interpretation, the Physical Trade Balance (PTB) is the most widely used indicator as a proxy for EUE (Dorninger and Eisenmenger, 2016; Infante-Amate and Krausmann, 2019; Samaniego et al., 2017). The PTB is the difference between the physical imports and exports of a territory, so its interpretation is the inverse of that of the monetary trade balance (EUROSTAT, 2018; Krausmann et al., 2017; UNEP, 2010). This paper uses both the PTB and its equivalent for the consumption approach, the Raw Trade Balance (RTB). The PTB and RTB allow the analysis of environmental burden transfers between countries, as well as the identification of inequality in their distribution (M. Pérez-Rincón et al., 2018). Countries with deficits (exports exceeding imports) will be ecologically harmed by international trade, while those with surpluses (imports exceeding exports) are ecologically benefited. The value of the PTB or RTB indicates the ecological burden that each country internalises (when negative) or externalises (when positive). The use of the territorial method or the consumption method significantly changes the level of ecological inequality. In general, we consider it more appropriate to use the RTB, as it assigns the ecological burden to each country according to its final consumption of goods.

### 2.3. Environmental Impact

To approximate the environmental impact, this paper uses material consumption indicators. The basic MFA indicator, common to territorial and consumption approaches, is Domestic Extraction (DE). Adding physical imports to DE and deducting physical exports yields material consumption, which provides information about the materials an economy needs to function. Using the territorial method, physical trade flows only represent the weight of the traded goods, resulting in Domestic Material Consumption (DMC), which indicates the materials used in domestic production and approximates the impact occurring within the borders of the territory (Ayres and Ayres, 1998; Daniels and Moore, 2001; Dittrich et al., 2012b; EUROSTAT, 2018; Schandl et al., 2018). Through the consumption method, physical trade flows cover all materials used in the production of the final traded good, resulting in the Material Footprint (MF), which indicates the materials used to produce the goods consumed by a territory's domestic demand, regardless of where they were produced (Arto et al., 2012; Dittrich et al., 2012a; Schaffartzik et al., 2015; Schandl et al., 2018). This indicates the impact for which a country's final consumption is responsible, regardless of where it occurs. A summary of the MFA indicators used in this article is presented in Table 1.

One of the most widely used tools to study the evolution of material requirements is the analysis of dematerialization. Dematerialization occurs when there is a decoupling between GDP and material consumption growth, which indicates that the amount of resources used per unit of GDP is decreasing (Fischer-Kowalski and Haberl, 2015; Ruffing, 2007; UNEP, 2011). If the decoupling occurs because material consumption grows, but to a lesser extent than GDP, relative or weak dematerialization occurs; if the decoupling occurs because material consumption decreases, absolute or strong dematerialization occurs. (Giljum et al., 2005; Krausmann et al., 2017; UNEP, 2011; Wiedmann et al., 2015). Although the term dematerialization is used in both senses, it only really makes sense when dematerialization occurs in absolute terms, as this is the only case where material consumption actually decreases (Martínez-Alier, 2004). In this paper, dematerialization is analysed for the material consumption indicators and for the DE.

### 2.4. Limitations and Future Research

One of the main limitations of this work is that part of the data in the Global Material Flows Database are estimates, as indicated in its technical annex (UNEP, 2018). Material consumption indicators are an approximation of the ecological or environmental impact of a territory, in which the damage caused is not specified and waste and emissions are not included (Krausmann et al., 2017). Similarly, both RTB and PTB are partial indicators of EUE. Regarding the TOT, in this paper they are constructed through eq. 1, so the actual prices of each kilogram of goods are not used. Nevertheless, we consider that the TOT calculated

**Table 1**
Summary of MFA indicators.

| Indicator | Abbreviation | Method | Definition | Calculation |
|---|---|---|---|---|
| Domestic extraction | DE | Both | Biotic and abiotic materials extracted from nature and used in some socio-economic process. | |
| Physical imports | Imports | Production | All materials imported. | |
| Physical exports | Exports | Production | All materials exported. | |
| Raw materials equivalents imports | RME Imports | Consumption | All materials used along the supply chain to produce the final exports. | |
| Raw materials equivalents exports | RME Exports | Consumption | All materials used along the supply chain to produce the final exports. | |
| Physical trade balance | PTB | Production | Difference between the RME imports and the RME exports of a territory. Its interpretation is the inverse of that of the monetary trade balance. | Physical imports - physical exports |
| Raw trade balance | RTB | Consumption | Difference between the RME imports and the RME exports of a territory. Its interpretation is the inverse of that of the monetary trade balance. | RME imports - RME exports |
| Domestic material consumption | DMC | Production | Indicates the materials used in domestic production and approximates the impact occurring within the borders of the territory. | DE + PTB |
| Material footprint | MF | Consumption | Indicates the materials used to produce the goods consumed by a territory's domestic demand, regardless of where they were produced. Represents the impact for which a country's final consumption is responsible, regardless of where it occurs. | DE + RTB |

Source: own elaboration based on data from EUROSTAT (2018), Krausmann et al. (2017), Schandl et al. (2018), UNEP (2018).

according to eq. 1 provide more interesting information in ecological terms.

Moreover, in the analysis of South America, Venezuela has been omitted for reasons of data availability and reliability, as well as Guyana, Suriname and Trinidad and Tobago because of the distortions they cause to the set due to their differences in size, activity, and other characteristics. Finally, the selection of the time interval is conditioned by the availability of part of the data.

The main future ampliation that could be made to this work is in the time interval, subject to data availability. It would be of great interest to analyse bilateral relations with the main partners in the region and in each of the countries that make up the region. Analysis from an output perspective, through waste and emissions, would be a great complement to the conclusions of this work.

## 3. Results

### 3.1. Ecologically Unequal Trade and Unfavourable Terms of Trade: The Paradox of Deficit Balances

This section analyses South America's trade flows and compares them with those of other countries, with the aim of quantifying the EUE and explaining its origin. Fig. 1 shows physical exports, physical imports, and their balance, both in direct terms and in RME.

Both through the territorial and the consumption method, there is a physical trade deficit in the whole period analysed, which means that South America suffers an unfavourable EUE. The omission of ITF is detrimental to South America, even though it exports mainly raw materials. In fact, the ITF of imports are proportionally higher than those of exports, but the volume of exports is much higher, resulting in a considerably higher RTB (in absolute value) than the PTB.

Fig. 2 plots RTB and PTB for South America, USA, China, and the EU-15, allowing a comparison between countries and between the territorial and the consumption method.

The high dependence on the USA and the EU-15 in terms of RTB is

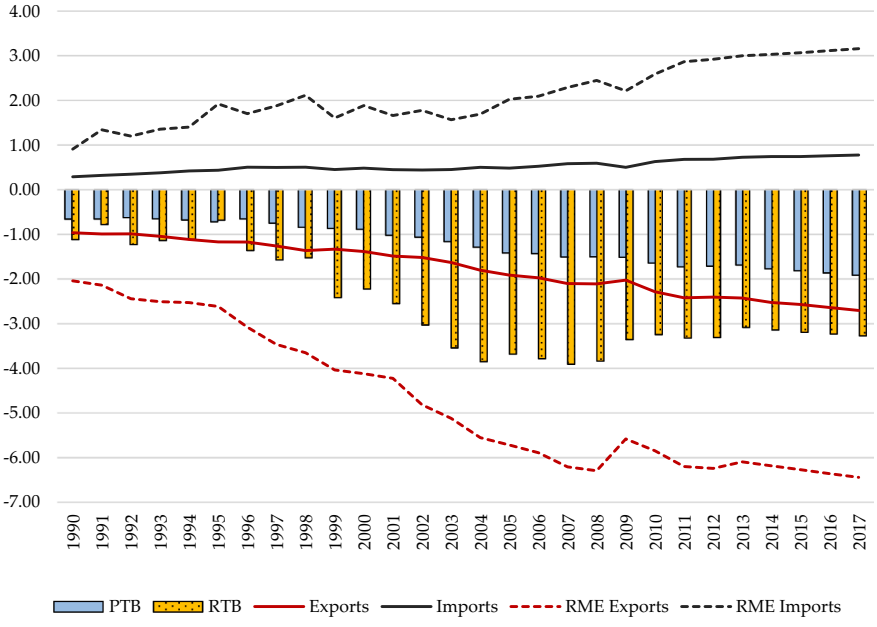


**Fig. 1.** PTB and RTB of South America, tonnes per cápita.
Source: own elaboration based on data from Global Material Flows Database and World Bank.

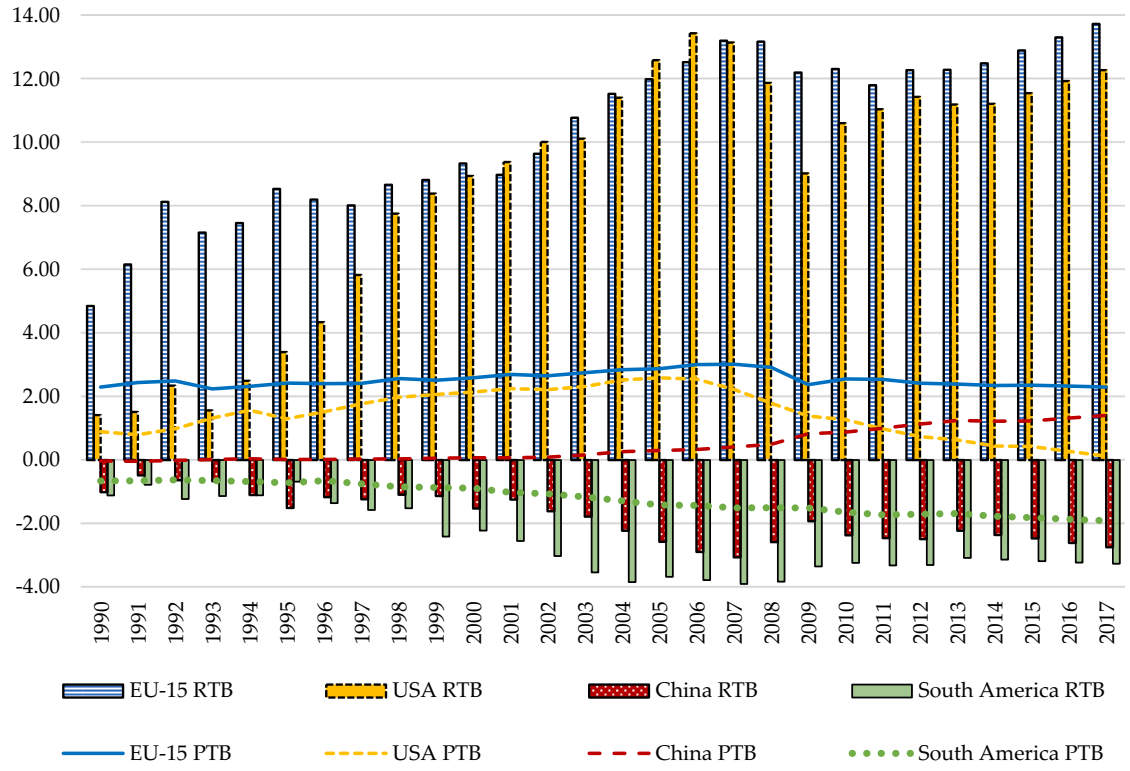


**Fig. 2.** RTB of South America, USA, China, and EU-15.
Source: own elaboration based on data from Global Material Flows Database and World Bank.

remarkable, while China and South America maintain a large deficit that evolves in a similar way, despite the fact that Chinese exports are mainly composed of manufactured goods (Pérez Lagüela, 2017; Salvador, 2012). However, in terms of PTB, the situation changes substantially: not only do the EU-15 and the USA have considerably lower values, but the trend is even decreasing, especially in the case of the USA. On the other hand, China shows a physical trade surplus, despite being the world's largest exporter, because of not accounting for IF.

Although the physical trade deficit is a constant in South America, regardless of the method used to calculate it, the monetary trade balance is more unstable, as can be seen in Fig. 3.

Looking at both balances, it can be seen that South America often has physical and trade deficits, which is common in extractivist countries (Muñoz et al., 2009; Samaniego et al., 2017). There are only periods of clear and continuous trade surpluses in part of the 2000s, because of an upward trend in commodity prices, but the trade and monetary balances do not correspond to each other in any way.

Fig. 4 shows South America's TOT, which are unfavourable

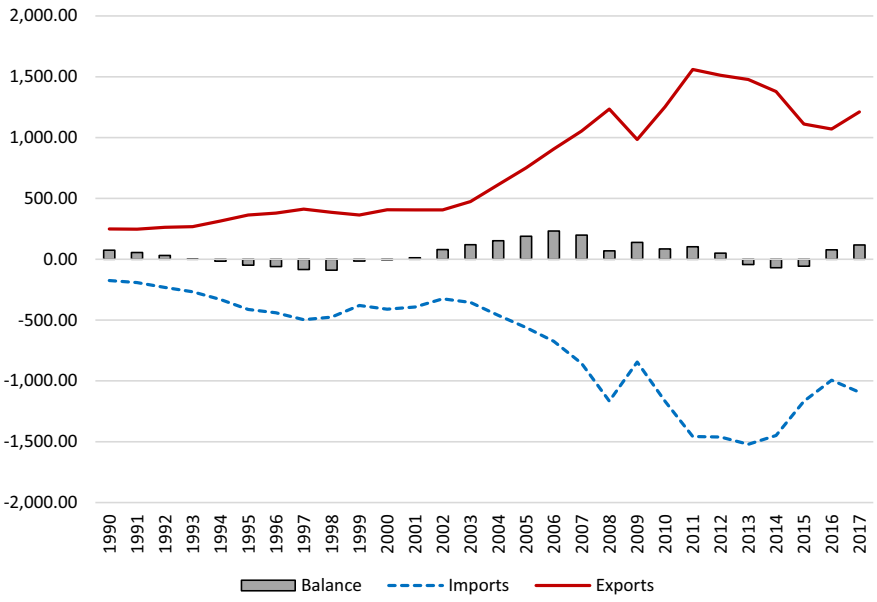


**Fig. 3.** Monetary trade balance, US Dollars per capita.
Source: own elaboration based on data from WTO.

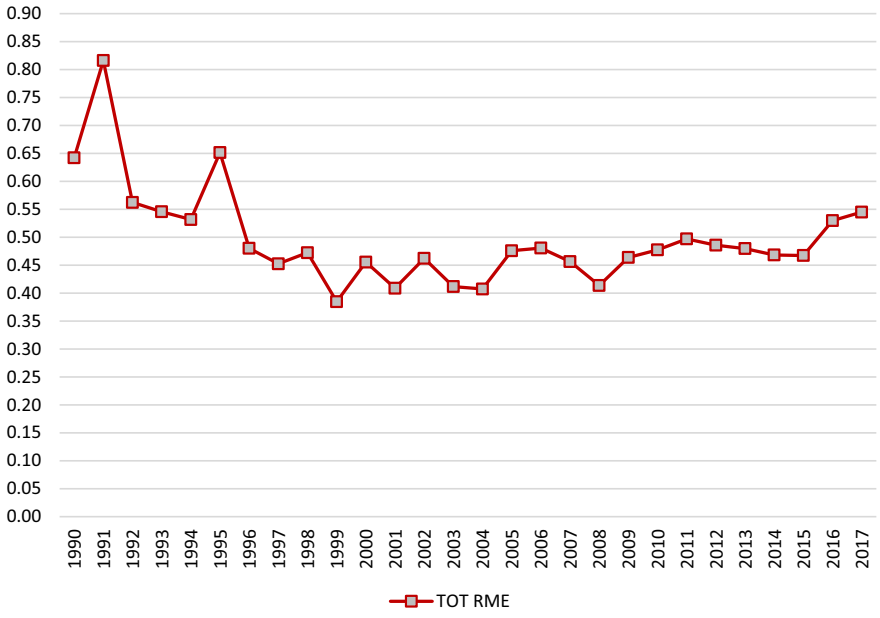


**Fig. 4.** South America's TOT using raw material trade flows.
Source: own elaboration based on data from Global Material Flows Database and WTO.

throughout the series. During the first part of the series, they get noticeably worse. While during the 2000s commodity prices evolve positively for South America, import prices also rise, preventing a clear improvement in the TOT. Only in recent years does there seem to have been some improvement thanks to a reduction in the cost of imports.

### *3.2. Environmental Impact in South America: Context and Evolution Through Production and Consumption Methods*

This section analyses the evolution of the total environmental impact of South America, using the two methods and comparing it with other countries to provide context. Fig. 5 shows the DE, DMC, and MF for South America.

The trend for all three indicators is increasing over most of the period, indicating that environmental impact is increasing. The fact that the DE is above the DMC and the MF implies that South America extracts more materials than it consumes, regardless of the method considered, a common occurrence in extractivist countries or regions.

In terms of dematerialization, the use of the territorial approach or the consumption approach generates important differences, as can be seen in Fig. 6.

In South America, the indicator that grew the most in the period analysed was the DE, closely followed by the DMC. The MF follows another trend, reaching periods of dematerialization, although they coincide with stages of economic crisis in several countries in the region. In any case, in recent years it has come much closer to the DE and DMC and any hint of dematerialization has disappeared. In China, DE, DMC, and MF grow in a similar way, at a very high rate, but at relative

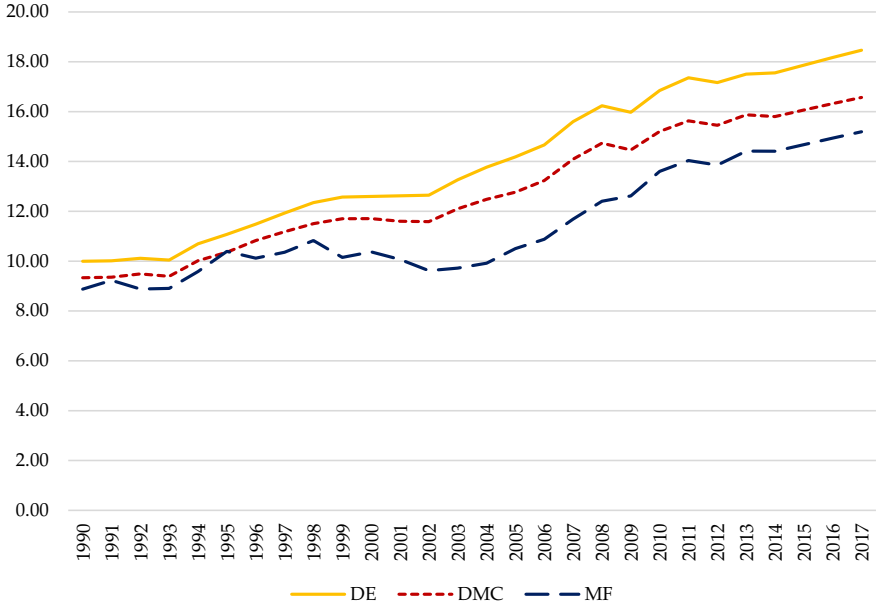


**Fig. 5.** DE, DMC and MF of South America, tonnes per capita.
Source: own elaboration based on data from Global Material Flows Database and World Bank.

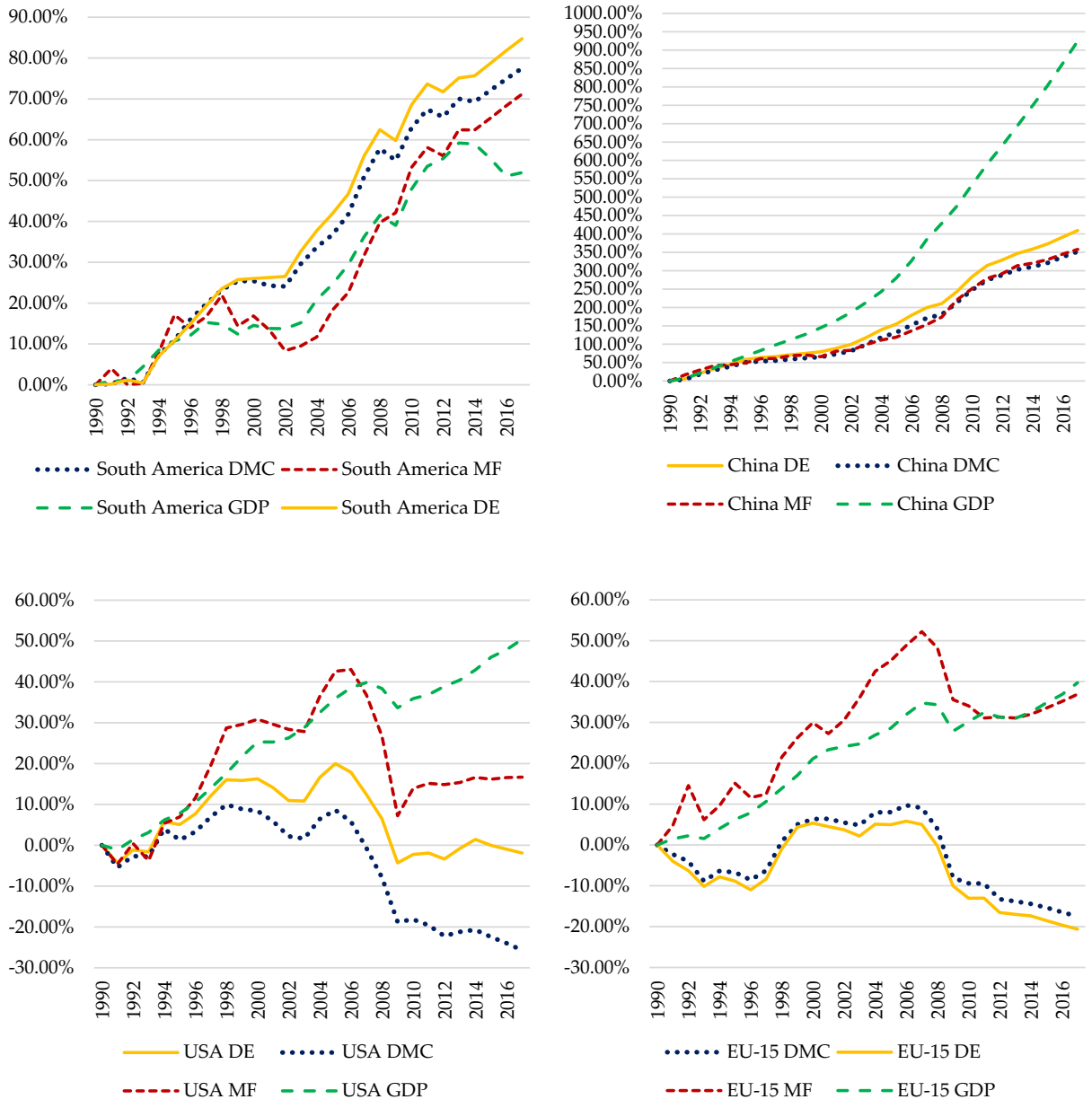


**Fig. 6.** Growth rates of DMC, DE, MF and GDP per capita, percentage.
Source: own elaboration based on data from Global Material Flows Database and World Bank.

dematerialization values because high growth does not reach GDP values. China is a large net physical exporter, but its exports are mainly composed of manufactures. The cases of the USA and the EU-15 are different, although like each other. In both cases, there is absolute dematerialization for DE and DMC, which behave in almost the opposite way to the MF. In terms of the MF, relative dematerialization only occurs after the 2008 Crisis, very tightly in the case of the EU-15.

Fig. 7 shows the values in Fig. 6 in absolute terms, which provides a better context for the information in Fig. 6.

Again, it is possible to see the wide differences between the territorial method and the consumption method. In terms of DMC, China has the highest value since 2012, while South America exceeds the EU-15 in recent years, approaching the USA. By contrast, in terms of MF, neither China nor South America outperforms the EU-15 or the USA, with South America maintaining a considerably lower value than any of the other territories. Fig. 8 shows the difference between the MF and the DMC, equivalent to the difference between the RTB and the PTB.

The ITF balance makes it possible to see the difference between the environmental impact assigned to each region through the territorial method and the consumption method. Through the territorial method, exporting countries have a higher material consumption, which corresponds to the environmental impact they take on. In contrast, importing countries have a much more moderate burden and therefore have a lower environmental impact on their territory. However, the environmental impact associated with each country's final consumption, as indicated by its MF, is much higher in the case of importing countries.

## 4. Discussion

In the neoclassical economic literature, the existence of a situation of ecological inequality between countries is not considered. Extractivist specialisation is explained by the comparative advantage given to the South American region by its resource endowment, and free trade is attributed with the ability to define prices that reflect the ecological impact, allowing these countries to develop and then repair this ecological damage with surpluses.

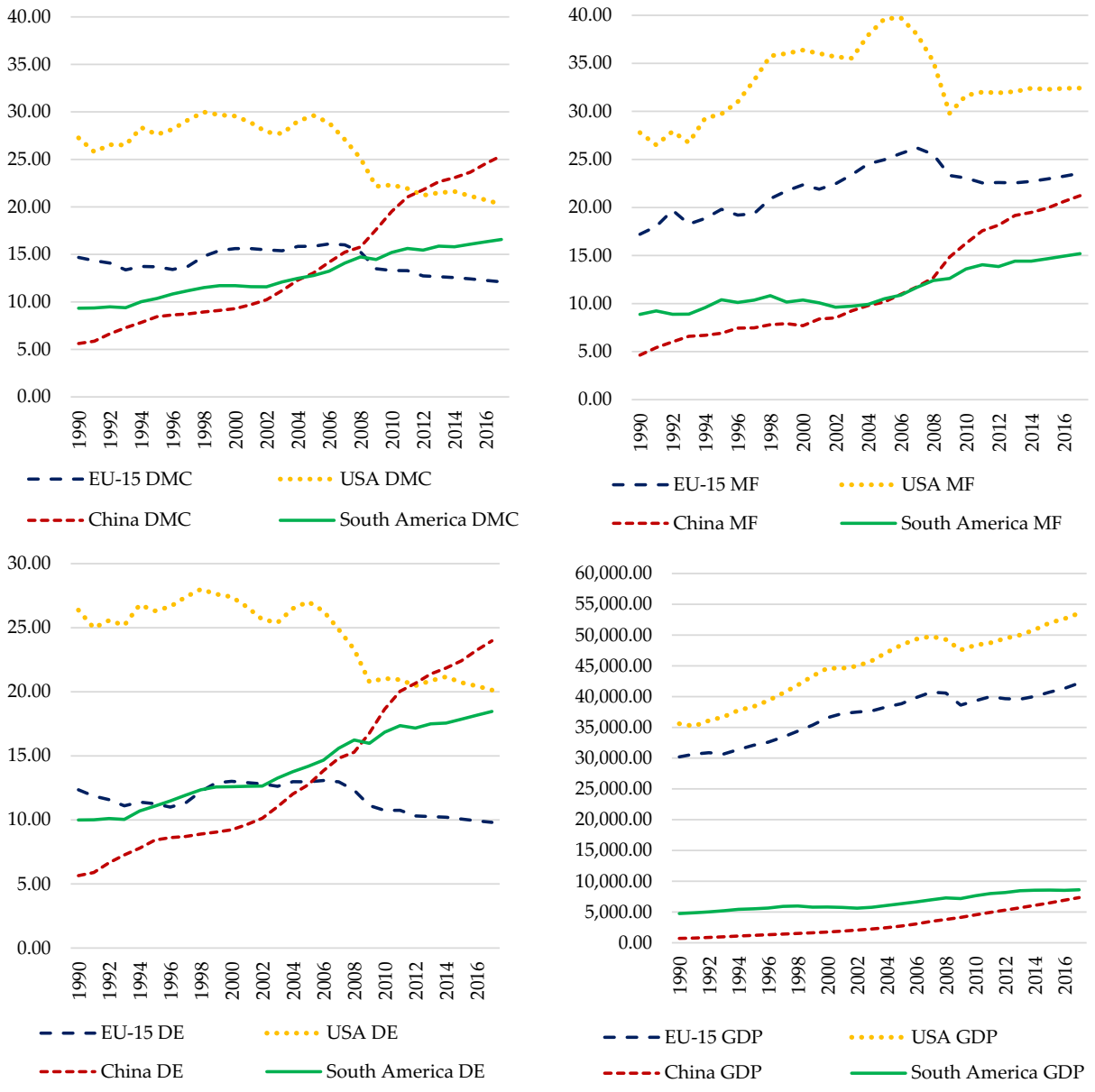


**Fig. 7.** DMC, MF, DE (tonnes per capita) and GDP (2010 US Dollars per capita).
Source: own elaboration based on data from Global Material Flows Database and World Bank.)

RTB and PTB allow the measurement of the EUE, but the PTB, obtained using the territorial method, omits ITF, which penalises exporting countries and underestimates the external dependence of importing countries. Through the RTB it is evident that South America suffers from EUE, in the same way as China. On the other hand, in both the USA and the EU-15 the direction of the EUE is reversed, so that these countries benefit, in ecological terms, from their trade relations. In fact, the positive RTB of the USA and the EU-15 is, in absolute value, much higher than the negative RTB of South America or China, so that these developed countries spread their ecological load over many different territories.

However, despite exporting far greater quantities of resources than it imports, South America's monetary trade balance alternates between periods of deficit and surplus. The difference between the value added of exports and imports causes South America's TOT to be chronically unfavourable, which explains the paradoxical situation of the trade balances. The combination of extractivism and unfavourable TOT leads South America into a situation known as the specialisation trap (RØpke, 1994). To try to raise revenues and cope with debt payments or balance of payments imbalances, extractivist countries' only option is to increase production, which puts downward pressure on prices. Consequently, both EUE and environmental impacts increase. On the other hand, the option of improving the value added of exports through processing is remote, as extractivist countries do not usually have a developed industry. At the same time, the development of a local industry is limited by tariff escalation, a type of tariff practice widespread in many developed countries that progressively taxes imports according to their degree of processing (Muradian and Martinez-Alier, 2001; RØpke, 1994). In this way, free trade exists only partially, as there are mechanisms that limit the possibilities for development and economic diversification in extractivist countries, guaranteeing their status as exporters of raw materials while providing a way to alleviate ecological pressure in more developed countries, as can be seen in their high RTB.

Free trade plays a central role in the maintenance of the extractivist model and the EUE in South America. Countries such as China followed a process of industrialisation in which partial free trade was combined

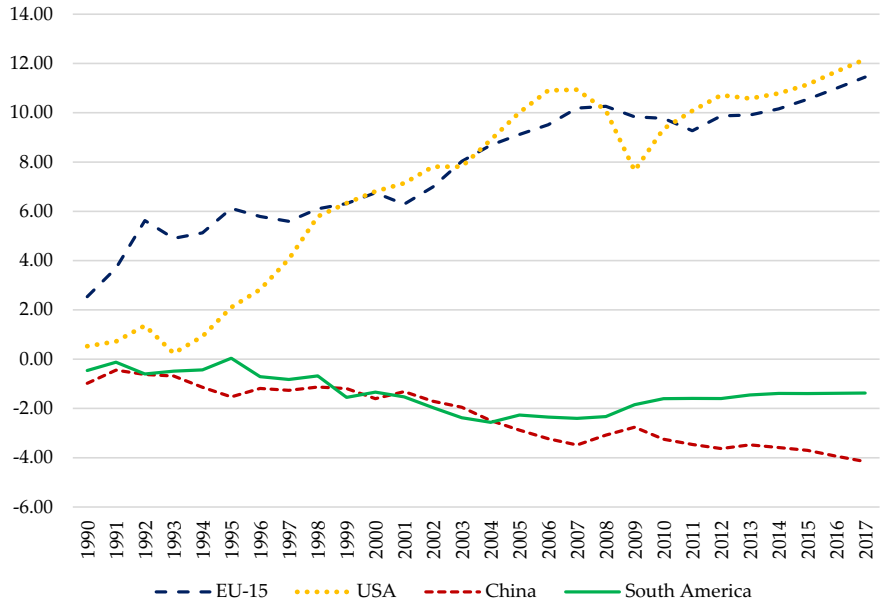


**Fig. 8.** Indirect Trade Flows Balance, tonnes per capita.
Source: own elaboration based on data from Global Material Flows Database and World Bank.

with a high level of protection for certain sectors (Bustelo and Fernández Lommen, 1996; Salvador, 2008). China has managed to develop a very strong domestic industry and to progressively improve its position in global value chains. However, in ecological terms the results have not been positive, as it has a high environmental impact and maintains an EUE with the rest of the world, despite being a major importer of raw materials. Therefore, the path to leaving behind extractivism must involve the design of strategies focused on domestic demand, with exports playing a secondary or complementary role. However, economic sectors oriented towards domestic demand should be developed according to criteria of sustainability and dematerialization as far as possible, avoiding the substitution of external environmental impact by domestic environmental impact.

The EUE has significant effects on the ecological impact of South America, causing these countries to have a much greater internal ecological impact, measured through the DMC, than the impact for which the country's final consumption is responsible, measured through the MF. This situation contrasts significantly with the EU-15 and the USA, where the DMC is much lower than the MF. The difference between the DMC and the MF shows that the EUE eases to alleviate ecological pressure in developed countries, allowing them to even achieve dematerialization, although they have only displace their environmental load to other parts of the world (Dittrich et al., 2012a; Givens and Huang, 2021; Schandl et al., 2018; Wiedmann et al., 2015). The divergence between the DMC and the MF grows as the processes of productive delocalization progress, which allows companies in the most developed countries to keep only the activities with the highest value added in their territory of origin. In fact, the MF of these countries does not stop growing except during the periods of greatest effect of the 2008 Crisis.

It is noteworthy that the consumption method tends to underestimate the responsibility of exporting countries (Piñero et al., 2019). However, it should be noted that the colonial past, the specialisation trap, and the asymmetries of free trade make it very difficult for extractivist countries to change their economic model. At the same time, developed countries have historically maintained advantageous trade conditions with extractivist countries and have greater capacity to act. Therefore, in a context of analysing global environmental justice, the consumption method is more appropriate, although a shared responsibility approach would be more appropriate, but data availability is still very limited.

Taking all the above into account, the hypothesis that economic growth leads to a reduction in ecological impact is not proven for South America. The ecological impact grows during the entire period analysed, even above GDP growth. Moreover, EUE is maintained and there is no sign that the economies of these countries diversify and allow for a reduction in EUE and ecological impact. These assumptions do not hold true in China either, where very high GDP growth is followed by very high values of growth in ecological impact. In the USA and the EU-15, the hypothesis can be interpreted as being fulfilled when analysing the DMC, but the reality is that the ecological impact is simply shifted in greater quantity to other countries, as can be seen through the MF. The comparison of the territorial method with the consumption method not only facilitates the identification of the environmental burden shifted from rich to less developed countries, but also calls into question the existence of absolute dematerialization, i.e. the independence of economic growth from material consumption (Alonso-Fernández and Regueiro-Ferreira, 2021; Arto et al., 2012). Trade liberalisation policies have led to the relocation of a large part of production from developed countries to poor countries to reduce costs, which has indirectly also led to the environmental load displacement.

## 5. Conclusions

This article has analysed the effects of extractivist specialisation and EUE on material consumption in South America. In addition, this has made it possible to analyse the evolution of the relationship between economic growth and material consumption in South America and in the countries used for comparison, China, the USA, and the EU-15.

The combined use of the territorial and consumption methods makes it possible to determine the significant volume of EUE hidden by the territorial approach in South America, because of its more limited consideration of physical trade flows. As exporting countries, both South America and China have a considerable deficit in their RTB, which contrasts with the huge surplus of the USA and the EU-15. This is a good illustration of the environmental load displacement from developed to less developed economies, which are increasingly playing more specific roles as suppliers of raw materials or industrial goods.

Free trade is a key factor in explaining the EUE, as it facilitates both productive relocations and the control of natural resources by more developed countries. The promotion of development through

commodity exports has deepened the extractivist specialisation of South American countries. At the same time, unfavourable TOTs, resulting from the significant difference in value added between their imports and exports, and the usual strategy followed by many developed countries of setting progressive tariffs according to the value added of the traded goods, has led to South America being caught in a specialisation trap. The only way for these countries to increase their incomes and finance imports or meet debt payments is to increase commodity production, because in the commodity market it is not easy to raise prices, they have hardly any internationally competitive industries, and their industrial exports are constrained by the tariff strategy of developed countries.

Therefore, South America's environmental impact is growing, especially in territorial terms. A comparison between this method and the consumption method shows that South America has a higher domestic impact than its responsibility, based on final consumption. This is an expected result, given the large EUE. It is noteworthy that, regardless of the method used, GDP and material consumption have a positive relationship, so that it can be ruled out that economic growth leads to a reduction in material consumption in the case of South America, which is extensible to the case of China.

The differences between methods are considerably greater in the case of the USA and the EU-15, where the territorial approach indicates that there is dematerialization, while the consumption approach only shows relative decoupling in the periods following the 2008 crisis. In the case of these countries, there is only an inverse relationship between growth and material consumption for the DMC, which is a consequence of the burden shifting favoured by productive relocations and free trade in recent decades. In terms of consumption, it is not possible to speak of a reduction in material consumption.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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