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STRUCTURAL CHANGE IN THE 21ST CENTURY AND THE CENTER-PERIPHERY RELATIONSHIP: OPPORTUNITIES AND CONSTRAINTS FOR LATIN AMERICA

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CENTRO DE DESENVOLVIMENTO E PLANEJAMENTO REGIONAL

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Sumário

Structural Change in the 21st Century and the Center-Periphery Relationship: Opportunities and Constraints for Latin America

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Abstract: The purpose of this paper is to analyze the foreign trade of biodiversity products (BioTrade) from a Latin American structuralist perspective and propose economic policy recommendations. Latin America (LA) is one of the most biodiverse regions in the world, which grants it a competitive advantage. Indicators reveal that the Center-Periphery relationship persists in manufacturing activities, modern services, and biodiversity-related trade. The primary reason for this is the historical lack of endogenous technological progress in LA countries, which limits the ability to harness economic opportunities. The principal economic policy recommendation is the formulation and implementation of an industrial policy that strategically leverages the region's biodiversity.

Keywords: Economic Development; Structuralist Economics; Biodiversity.

JEL Classification: O1; O4; L80

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1.Introduction

Economic development manifests through increased investment in dynamic sectors, enhanced productivity, and greater innovation capacity, all of which directly contribute to rising per capita income and improved living standards. Structuralist economics[2] undersCenters the importance of production relations, with a sectoral dimension as its foundation. From this perspective, shifts in productive composition, particularly in favor of industrialization, are pivotal to explaining long-term economic growth (Lowe, 1955; Syrquin, 1988).

Latin American structuralism emerged prominently through studies conducted under the Economic Commission for Latin America and the Caribbean – ECLAC (CEPAL) beginning in the 1950s. Central to ECLAC's analysis is the international trade dynamic between developed and underdeveloped nations. Researchers identified two poles, referred to as "Center" and "Periphery," and documented a trend of deteriorating terms of trade for the latter. Within this framework, trade interactions between Center and Periphery nations engender heterogeneous productive structures in terms of productivity and technological progress, particularly in Latin America.

Neostructuralism, which arose in the 1990s, represents a new theoretical phase within ECLAC's effort to understand the enduring peripheral condition of Latin America and the Caribbean after the process of Import Substitution Industrialization (ISI). This approach argues that ISI strategies were insufficient in creating a stable macroeconomic environment with low inflation and failed to internalize technological progress (Fajnzylber, 1983). These deficiencies, especially the absence of a dynamic endogenous nucleus for technology generation, have precipitated a range of challenges related to sustained long-term economic development.

In the first two decades of the 21st century, ECLAC studies expanded their focus to include income distribution, equity, and sustainable development, addressing issues such as environmental degradation and climate change (Cepal, 2014; 2016). More recently, biodiversity has gained prominence, with concerns converging on the preservation and strategic utilization of this resource as a tool for economic development (Cepal, 2020; 2022).

According to Grooten and Almond (2018) and IPBES (2019), global ecosystems and biodiversity are in rapid decline. Between 1970 and 2014, there was a 60% reduction, with Latin America and the Caribbean leading these losses. This decline reached 89% across 1,040 populations,

[2] The structuralist approach can be divided into two strands: i) Anglo-Saxon structuralism or "original structuralism", and; ii) Latin American structuralism. In Anglo-Saxon structuralism, authors such as Paul Rosenstein-Rodan, Nurkse, Lewis, Hirschman and Myrdal stand out. These authors share the idea that underdevelopment is a stage to be overcome in the process of economic development. For more details, see: Ancochea, (2007).

representing 689 species. One of the primary drivers of this degradation is the unsustainable exploitation of natural resources, as the region's competitiveness relies more on these resources and cheap labor than on technological capabilities (Cepal, 2020).

In this context, the lack of endogenous technological progress directly intersects with concerns about biodiversity. Latin America, home to one of the planet's richest biodiversities, has positioned itself in international trade primarily as an exporter of raw natural resources due to its structural conditions. Thus, the biodiversity "asset," which represents a strategic window of opportunity for the region, risks being absorbed into the traditional logic of the Center-Periphery structure. This is the central hypothesis of this paper.

This study contributes to the literature in two ways: i) by providing a structuralist analytical treatment of the BioTrade theme, and ii) by presenting economic policy recommendations that highlight the wealth of Latin America and the Caribbean's biodiversity as a novel opportunity for fostering economic and social development within the framework of environmental protection.

The paper aims to analyze the foreign trade of biodiversity products (BioTrade) through a Latin American structuralist lens and propose economic policy recommendations. To this end, it offers a brief analysis of the foreign trade of manufactured goods and modern services to examine the Periphery's position in terms of productive structure, followed by a specific analysis of BioTrade.

The article is structured into six sections, including this introduction. Section 2 presents the theoretical framework grounded in ECLAC thought. Section 3 addresses the methodology, while Section 4 is dedicated to the analysis of results. Finally, the concluding section provides final considerations.

2.Latin American Structuralism: From Its Original Approach to Recent Advances

Latin American structuralism originated in the late 1950s within the framework of Economic Commission for Latin America and the Caribbean - ECLAC (CEPAL). This school of thought is an articulated set of ideas that seeks to explain the underdevelopment of Latin American countries. It is fundamentally based on three interconnected pillars: (1) the Center-Periphery relationship; (2) the deterioration of the terms of trade; and (3) structural heterogeneity.

The first central proposition is the existence of a systemic polarity between developed countries (Center) and underdeveloped countries (Periphery). This polarity entails several implications that hinder the growth of the Periphery (Love, 2005).

Central countries are characterized by a homogeneous economic structure, organized labor systems, and leadership in the generation and dissemination of technological progress. In contrast, peripheral countries exhibit heterogeneous economic structures, fragmented labor unions, and technological dependence.

In this context, structuralists observed that productivity levels in developed countries were significantly higher, suggesting a dichotomy in the productive structure between the Center and the Periphery (Prebisch & Cabañas, 1949; Furtado, 1963; Pinto, 1965; 1970). This observation is directly related to the second pillar, which addresses structural heterogeneity. According to Prebisch and Cabañas (1949), the main issue in the Periphery lies in the disparity of productivity levels across different economic sectors.

This productivity differentiation led Pinto (1970) to propose the existence of three productive strata in Latin America: i) the primary sector, characterized by low productivity and per capita income, resembling colonial production patterns; ii) the intermediate sector, operating with productivity levels near the national average; and iii) the modern sector, encompassing industrial and service activities with productivity levels comparable to developed economies.

The aforementioned structural configuration directly impacts average productivity levels due to the predominance of technologically lagging sectors. Consequently, this reinforces the differentiation in real income levels between the Center and the Periphery. Thus, it can be inferred that a country's productive organization determines its relative position within the global economic system. As Sunkel (1971, p. 26-27) noted, "Given the structure of the system, its mode of operation is defined, which, in turn, generates the outcomes produced by the system." For this reason, Prebisch and Cabañas (1949, p. 83) argued that "while the Centers retained the full fruits of their industrial technological progress, the peripheral countries transferred to them a portion of the fruits of their own technological progress."

The combination of a heterogeneous productive structure with foreign trade dynamics that form and reinforce the Center-Periphery relationship contributes to the Periphery's predominant role as an exporter of primary goods. This dynamic aligns with the third pillar, which deals with the deterioration of terms of trade. Rodriguez (2009) identifies three distinct approaches to this issue: (1) the accounting version; (2) the cycles version; and (3) the industrialization version.

The accounting version questions the notion that industrial productivity growth in the Center, compared to the Periphery's primary production, guarantees lower prices for manufactured goods

purchased by underdeveloped countries. It is argued that, rather than decreasing, prices tend to rise, particularly for manufactured goods, due to the advanced stage of technological progress in developed nations. In this context, the average differential in labor productivity explains the unequal evolution between the two poles of the economic system.

The cycles version suggests that during periods of economic expansion, terms of trade tend to favor the Periphery. However, the opposite occurs during contractions, with greater intensity, which contributes to a long-term deterioration trend. This dynamic is primarily caused by the distinct structural configurations of the Center and the Periphery, influencing economic cyclical movements.

Specialization in the production of primary export goods makes the peripheral region more open to fluctuations in the level of economic activity in the central economies. In the growing phase of the cycle, the demand for raw materials and food expands and promotes a generalized increase in prices and income. In this case, the fruits of technical progress tend to transfer from the Centers to the Periphery. In the declining phase, an inverse movement is observed, the effects of which are more intense in the Periphery due to its heterogeneous, fragmented and dependent production structure.

The industrialization version analytically develops the concepts of specialization and heterogeneity. Specialization in primary activities and low-sophistication industries has significant implications for balance of payments (BP) imbalances. Under normal conditions, the primary export sector experiences slow growth in external demand. Simultaneously, the limited diversification of the productive apparatus, oriented toward import substitution, generates high demand for imported goods.

Moreover, as peripheral economies are characterized by low industrial productivity and abundant labor availability, compensation through low wages is permitted. That is, the fruits of technological progress are not fully absorbed by the local economy due to structural factors that exacerbate the deterioration of terms of trade, disadvantaging peripheral countries.

In peripheral countries, where specialization in raw material production for international markets is the primary means of integration into foreign trade and foreign currency generation, recurring pressures on the BP emerge whenever terms of trade become unfavorable.

2.1-The limitations of industrialization in the Periphery

The solution to circumvent the problem of external constraints, stemming from the need to achieve the intertemporal equilibrium of the BP (Balance of Payments) and heterogeneous

productivity, lies in the development of industry (Prebisch and Cabañas, 1949; Furtado, 1963; Rodriguez et al., 1995; Rodriguez, 2009).

Prebisch and Cabañas (1949) recognize that the industrialization of the Periphery is essential to capture a portion of the benefits from technical progress and progressively raise the standard of living of the masses. Considering that the incorporation and diffusion of new techniques are more intense in the industrial sector than in primary activities, it is assumed that the consolidation and expansion of this sector is a necessary condition for economic development (Furtado, 1963; Pinto, 1965; Prebisch; Cabañas, 1949).

Latin American countries, with technical support from ECLAC, undertook planning efforts aimed at industrialization. The Import Substitution Industrialization (ISI) model prevailed for almost the entire second half of the 20th century, with the state assuming roles such as regulator, producer, intervener, and investor. It was not uncommon for the national and international private sector to combine efforts with state support to shape the region's industrial structure (Suzigan, 1988; Nonnenberg, 2003). The strategy initially advanced in the durable consumer goods sector and later shifted towards intermediate and capital goods (Tavares, 1976), gradually aiming to implement all stages of the production process in the Periphery.

However, as argued by Albuquerque (2007), the ISI model contributed to the maintenance of incipient domestic industrial development and technological innovation. This occurred due to the manner in which protection for domestic producers and policies of subsidies for the importation of capital goods were implemented. Domestic production came to focus on simpler products or consumer goods, leading local industrial producers to sustain their productive capacity primarily through the absorption of specific technological innovations.

In other words, industry in the Periphery became a replicator of the external production pattern, so that the growth of underdeveloped economies resulted from the assimilation of prevailing techniques from the Center. Central countries disseminate new technologies across all economic sectors and develop the capital goods sector, while the Periphery remains dependent on imported technology (Furtado, 1963; Rocha, 2018).

The ISI model resulted in an incomplete process of industrialization because the modernization of domestic industry occurred through the adoption and updating of patterns and techniques systematically acquired from the central countries, with the main result being the structural underemployment of productive factors (Furtado, 1963; Albuquerque, 2007).

Incomplete industrialization and macroeconomic imbalances contributed to the decline of the ECLAC model. The economic crisis faced by Latin America during the 1980s led to a restructuring of Latin American structuralist thought. Simultaneously, economic policies based on the Washington

Consensus, focusing on fiscal adjustment and financial and trade liberalization, were implemented in these countries. However, the negative social impacts, combined with low growth rates resulting from these policies, intensified criticism of this approach and paved the way for the emergence of neo-structuralism.

2.2-Neostructuralism and recent advances

The analysis of the successes and shortcomings of ECLAC's economic policy proposals culminated in a new theoretical synthesis: neo-structuralism. Its hallmark was the document entitled *Transformación Productiva con Equidad* (Productive Transformation with Equity), published in 1990. This approach incorporated elements from previous thought and introduced new strategies for guiding economic policy.

Neo-structuralism recognized that Latin American countries face bottlenecks associated with macroeconomic imbalances, obsolete industrial plants, and technological lag, which block economic development (Cepal, 1990; Rodriguez, 2009). The new economic model advocates for competition mediated by the state, with the following pillars for development: i) fiscal balance with macroeconomic stability; ii) policies to induce a modern production structure; and iii) trade openness (Ffrench-Davis, 1988; Cepal, 1990; Ramos; Sunkel, 1993; Bielschowsky, 1998; Gwynne & Kay, 2000).

The proposed relationship between the state and the market is harmonious, where the partnership between both is strategic for creating an environment of healthy productive competitiveness (Missio; Jayme Jr., 2012). In other words, the state must prioritize equity and the strengthening of competitiveness through the incorporation of technical progress (Cepal, 1990). Additionally, to address the issues stemming from cyclical instability in economic activity, whether originating externally or internally, the state must emphasize fiscal discipline as a means of preserving its capacity for intervention during downturns in the economic cycle (Cepal, 1998).

Macroeconomic stability is essential for the state to invest in infrastructure, health, and education (Missio; Jayme Jr., 2012). Fiscal balance and the reduction of social inequality are key to development. Thus, it is assumed that fiscal balance and distributive measures are sine qua non conditions for long-term growth (Cepal, 1990).

Regarding productive development policy, Cepal (1990) argues that the state is an important partner in minimizing the uncertainties arising from the innovation process. The neo-structuralist

strategy includes both horizontal and microeconomic policies. The focus of public policies should be on enhancing the qualifications of micro-entrepreneurs and self-employed workers to foster a culture and environment conducive to innovation and integration into the competitive international landscape.

Finally, regarding integration into international markets, it is argued that economic openness provides access to the new technological dynamics embedded in goods and services and attracts external investment (Missio; Jayme Jr., 2012). According to Rodriguez (2009), neo-structuralism acknowledges the ongoing technological revolution accompanied by an intense process of globalization. It further recognizes that sectors with higher technological intensity and greater competitiveness achieve higher growth rates in international trade. In this sense, Latin American countries must create mechanisms to ensure that the domestic environment is conducive to innovation and open to external technology. These are key factors for reaching the technological frontier.

Studies conducted in the first two decades of the 21st century advanced the understanding that income distribution and equal access to opportunities are fundamental for development (Cepal, 2012; 2014). It is proposed that equality should be both the guiding principle and strategic objective of development, integrating sustainable economic growth with social inclusion and the reduction of inequalities (Cepal, 2012).

Additionally, sustainability emerges as an essential part of structural change. Cepal (2016) proposes environmental Keynesianism, which advocates for reducing dependence on fossil fuels and investing in green infrastructure and projects that decouple economic growth from carbon emissions while increasing energy efficiency. Recently, the institution has called for policies aimed at countering the trend of ecosystem destruction, the most direct implication of which is the loss of biodiversity (Cepal, 2020).

The 2020 report identifies three gaps in the region: i) the social gap, which addresses the need to promote inclusive growth; ii) the economic gap, which relates to growth with external restrictions; and iii) the environmental gap, which corresponds to the challenge of achieving economic growth with environmental preservation. As the region is characterized by high biodiversity, climate change, coupled with historical structural deficiencies (income concentration, deficient infrastructure, and low innovation capacity), may impose new limits on economic development.

Thus, albeit in an embryonic form, these propositions aim to promote the transition to a sustainable and ecosystemic productive use of Latin American biodiversity. It advocates stimulating activities related to bioeconomy, integrating sustainable agriculture, preservation, and the strategic use of genetic resources from plant, animal, biochemical, and microbial origins, as well as developing a bioindustry in Latin America and the Caribbean (Cepal, 2020; 2022).

In summary, recent studies recognize that Latin America, being a tropical region, is one of the most biodiverse areas. Technological advancements have been progressing toward incorporating the region's genetic resources as strategic inputs for economic development. In this context, Latin American countries may be facing another window of opportunity to promote economic growth with the incorporation of technical progress. This economic advantage has the potential to mitigate issues related to external bottlenecks, low innovation capacity, and the historical trajectory of economic and social exclusion, as well as contribute to the environmental protection of forests and the mitigation of climate change.

3.Methodological notes

The study adopts a quantitative approach, using data on international trade of biodiversity-derived products (BioTrade) to identify patterns in trade relations between countries. Parametric and non-parametric statistical tests, as well as regressions for pooled and panel data, were employed to assess whether there are differences in the BioTrade exports made by economies in the Center and the Periphery, considering the integration of countries into more sophisticated production chains.

The hypothesis to be tested is that the Revealed Comparative Advantage (RCA) indicator differs between central and peripheral countries, such that Latin American countries exhibit greater variance from the mean for biodiversity products characterized by low value-added aggregation. Following the methodology used by Oliveira Dias et. al., (2020), Levene's test was used to assess the homogeneity of variances of the Revealed Comparative Advantage (RCA) indicator between the Center (C) and the Periphery (P). The null hypothesis (H0) and the alternative hypothesis (H1) of the test are defined as follows:

H0: $\sigma_C^2 = \sigma_P^2$, (variances are equal)
H1: $\sigma_C^2 \neq \sigma_P^2$, (variances are different)

If Levene's test does not reject H0, homogeneity of variance is assumed, and the t-test is used to compare the means of the RCA indicator between the groups:

$$t = \frac{\bar{X}_c - \bar{X}_p}{\sqrt{s^2\left(\frac{1}{n_c}+\frac{1}{n_p}\right)}}, \quad (1)$$

where $\bar{X}_c$ e $\bar{X}_p$ are the means of the Center and Periphery groups, respectively; $s^2 = \frac{(n_c-1)s_c^2+(n_p-1)s_p^2}{n_c+n_p-2}$ is the pooled variance; n_c e n_p are the sample sizes, and s_c^2 e s_p^2 are the sample variances. The null hypothesis of the t-test is that the means are equal, and the alternative hypothesis is that they are different.

If Levene's test rejects H0, indicating heterogeneity of variances, the Mann-Whitney test, a non-parametric approach, is used to compare the medians of the two groups. The statistic for the Mann-Whitney test is based on the sum of the ranks assigned to the values of the RCA indicator, given the following hypotheses:

$H0: F_C(x) = F_P(x)$, the distributions of the groups are equal;
H1: $F_C(x) \neq F_P(x)$, the distributions of the groups are different.

where $F_C(x)$ e $F_P(x)$ are the cumulative distribution functions for the Center and the Periphery, respectively. The Mann-Whitney test is based on the calculation of the U statistic, which is given by:

$$U = \min(U_1, U_2), \quad (2)$$

where U_1 e U_2 are defined as:

$$U_1 = R_1 - \frac{n(n+1)}{2}, \quad (3)$$

$$U_2 = R_2 - \frac{m(m+1)}{2}, \quad (4)$$

where R_1 e R_2 are the sums of the ranks of the observations from groups 1 and 2, respectively, and n e m are the sample sizes of these groups, respectively. This combination of tests ensures that the comparisons between the groups account for the characteristics of the data, particularly with regard to the homogeneity or heterogeneity of the variances.

Regarding the estimated regressions, an initial basic model was fitted with a binary variable for the Center countries to check whether the mean RCA differs significantly between the groups:

$$RCA_{it} = \beta_0 + \beta_1 Center_{it} + \epsilon_{it}, \quad (4)$$

where VCR_i is the Revealed Comparative Advantage indicator for country i; β_0 e β_1 are the estimated parameters; *Center* is a binary variable that takes the value of one if the country belongs to the Center; and ϵ_i is the error term.

In addition to analyzing the coefficients and statistical significance of the estimated models, additional tests were performed to assess the adequacy of the statistical inferences made. The Hausman test was conducted to check whether the random effects panel model is consistent or if it is necessary to estimate fixed effects panel models. The Breusch-Pagan test was used to investigate the presence of heteroscedasticity in the residuals, ensuring that the assumption of constant variance was valid. In cases where heteroscedasticity was detected, robust standard error estimators by White were applied.

Countries were divided into Center (Western European countries and the U.S.) and Periphery (Latin American and Caribbean countries) based on the availability of data for each country. The database used is TraBio from the United Nations Conference on Trade and Development (UNCTAD), which contains data on bilateral and multilateral trade flows for 1,814 biodiversity-based products grouped into 13 categories (**Table 01**). The period considered in the study spans from 2010 to 2022.

Table 01 - Product groups in the TraBio classification

A	Live animals and plants
B	Food and beverages
C	Agricultural inputs
D	Natural ingredients
E	Perfumery, cosmetics, personal care, and preparations for cleaning environments
F	Pharmaceutical products
G	Hides, skins, leather goods, furs, and related products
H	Natural fibers and related products
I	Wood and related products
J	Plant materials for weaving and related articles
K	Other animal-derived products
L	Other plant-derived products
M	Miscellaneous

Source: UNCTAD (2023)

According to Unctad (2020), biodiversity-based products "are understood as all products of biological origin, including plant and animal species found on land, in water, and in the air" (Unctad, 2020, p.50). Goods produced or derived from the extraction of minerals, ores, or metals, such as

sands, oil, and gas, are not considered biodiversity-based products. To be considered a biodiversity-derived product, it must meet at least one of the following criteria (Unctad, 2020):

i) They are intrinsically and entirely based on biological resources themselves, in a little or non-processed stage (e.g., whole pineapples or ground coffee);

ii) When used as inputs, they are processed products that use only or primarily ingredients based on biological resources (e.g., cotton shirts, wooden furniture, or chocolate bars); and

iii) When derived, they are primarily derived from products based on biological resources (e.g., glycerol from natural oils and fats).

Finally, the set of variables used in this study is summarized in **Table 02**.

Table 02 – Summary of variables

Variables	Source
Areas of high biodiversity	UNbiodiversityLab
Revealed Comparative Advantage	TraBio/UNCTAD
Economic Complexity Index	OEC*
Export of high-tech manufactured goods	Worldbankdata
Forest structural condition index	UNbiodiversityLab
GDP per capita	Worldbankdata
Global BioTrade Exports	TraBio/UNCTAD
Global BioTrade Imports	TraBio/UNCTAD
BioTrade's share in GDP	TraBio/UNCTAD
Share of Information and Communication Technologies in service exports	UNCTADstat

Source: prepared by the authors. Note: Observatory Economic Complexity - OEC

4.Productive structure and Latin American foreign trade from a structuralist perspective

Table 03 summarizes the evolution of economic growth in the main regions of the world between 1970 and 2022, with special attention to Latin America and the Caribbean. Between 1970 and 2020, the average annual growth rate of the reference region was low (1.03%), when compared to other regions, such as Asia (3.16%), Europe (1.81%), North America (1.64%), and even Oceania (1.22%). Except for the 1970-1979 decade, in which growth was around 3.0%, it is noticeable that Latin America and the Caribbean have historically suffered from chronic structural problems lasting over three decades.

Table 03 - GDP per capita growth rate of world regions between 1970 and 2022

Regions	1970 - 1979	1980 - 1989	1990 - 1999	2000 - 2009	2010 - 2019	2020 - 2022	1970 - 2020
Africa	1,27	-0,82	-0,08	2,43	0,73	1,36	0,70
Asia	2,94	2,42	2,34	3,52	3,49	2,94	3,16
Europe	2,57	1,81	1,90	1,28	1,29	3,17	1,81

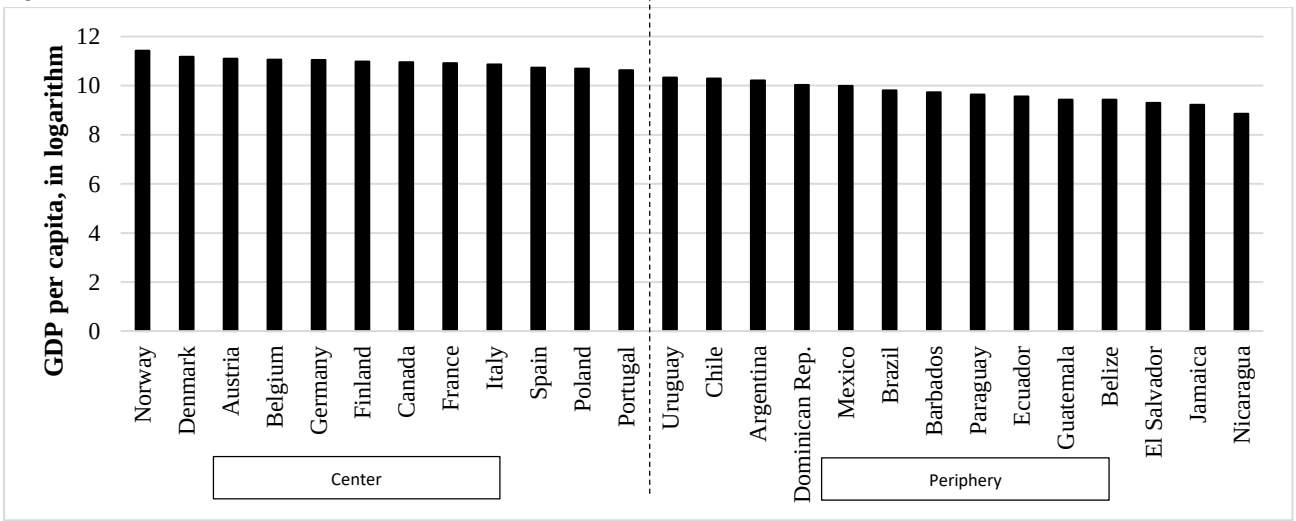
Latin America and the Caribbean	3,03	-0,53	1,28	1,34	0,18	3,19	1,03
Caribbean	2,60	1,67	1,36	1,51	0,79	2,40	1,44
Central America	2,97	-0,71	1,49	-0,26	1,01	2,99	0,95
South America	3,07	-0,68	1,17	1,97	-0,21	3,35	1,02
Northern America	2,27	2,17	1,99	0,59	1,24	2,32	1,64
Oceania	0,99	1,44	1,85	1,22	0,65	1,64	1,22
World	1,94	1,17	1,17	1,36	1,62	2,49	1,49

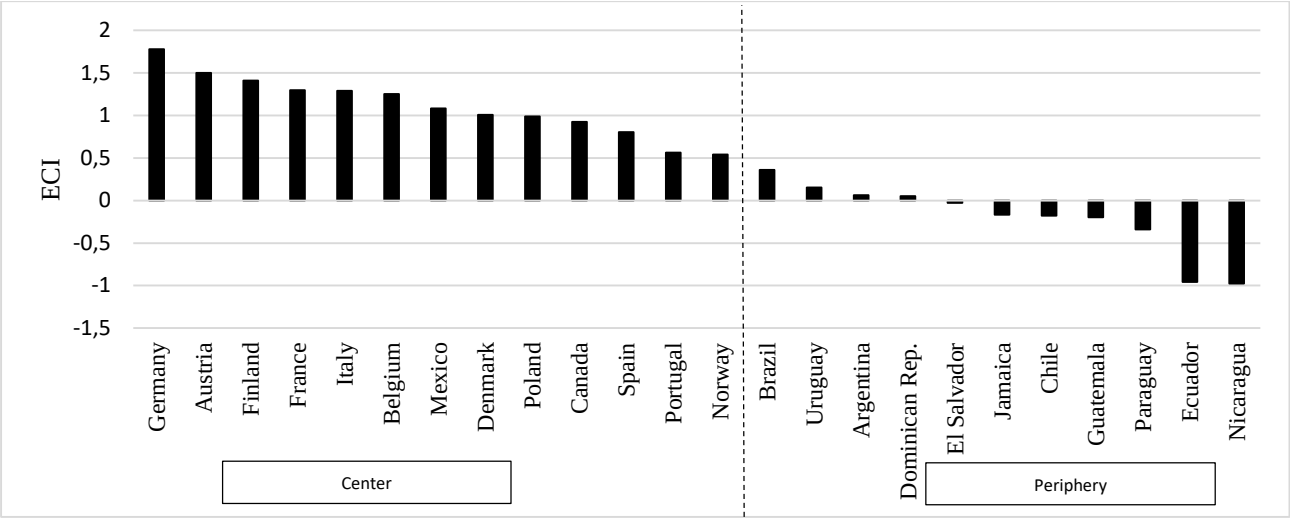
Source: Prepared by the author based on UNCTADstat.

The causes and consequences are extensively detailed in several studies (Prebisch; Cabañas, 1949; Furtado, 1961; 1969; Pinto, 1965; 1970; Fajnzylber, 1983; 1990). The most severe effects include income stagnation and its concentration in specific social groups, structural unemployment, low productivity, the lack of endogenous technical progress, and external constraints that place Latin American countries in a disadvantaged position within the global economic framework.

This can be observed when analyzing the production structure of the Periphery (**Figure 01**), composed of Latin American countries, in comparison with the Center, which consists of 16 high-income countries. When organizing the data on GDP per capita and the Economic Complexity Index (ECI) in descending order, the countries from these groups naturally separate. All the countries in the Center exhibit higher GDP per capita and ECI compared to those in the Periphery, highlighting a less sophisticated production structure in Latin American countries.

Figure 01 – GDP per capita and Economic Complexity Index (ECI), Center versus Periphery, 2022





Source: Adapted from Unctad, Observatory of Economic Complexity and World Bank. Economic complexity and BioTrade exports data available for only 11 Latin American countries.

These data highlight a clear disparity between the economies of the Center and the Periphery. Center countries have greater capacity to integrate into more sophisticated global value chains, whereas Periphery countries, including much of Latin America, still rely on sectors with low added value and limited economic complexity. The comparison between these two groups of countries reinforces the diagnosis that specialization in products with higher complexity and technological intensity is one of the factors distinguishing Center economies from Periphery economies, as analyzed in several studies by ECLAC (Prebisch, 1949; Furtado, 1966).

Therefore, by observing that all Center countries have higher GDP per capita and ECI than those in the Periphery, it is possible to conclude that the production structure of the Periphery is still characterized by reliance on sectors with lower complexity, while the countries constituting the Center have more diversified and technologically advanced economies. This contrast has important implications for economic development and for Latin America's integration into international trade.

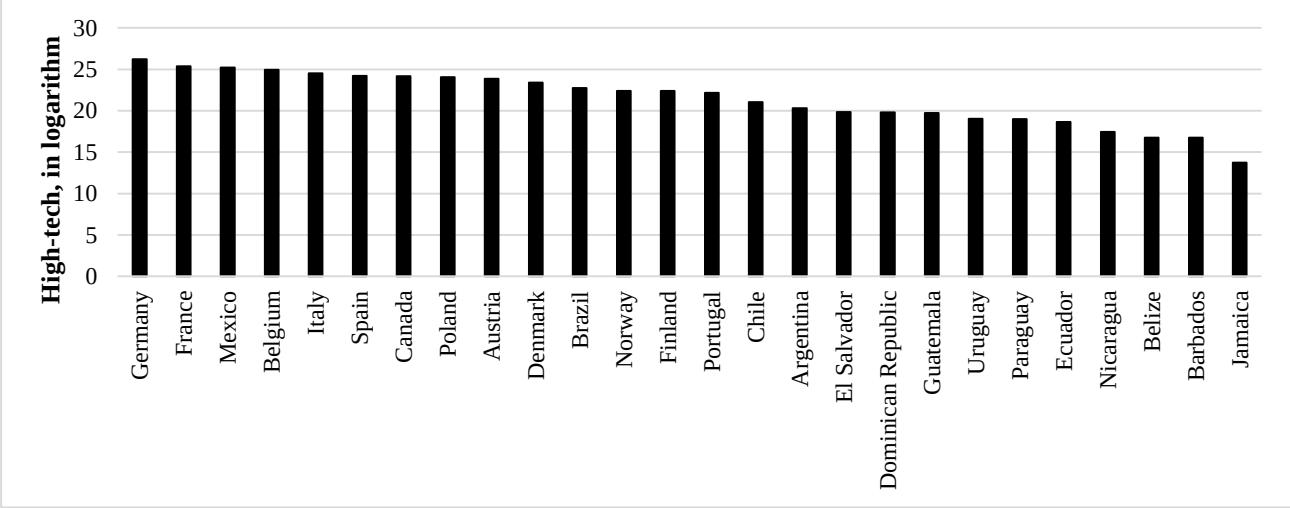
Moreover, in the absence of endogenous technical progress, the region's biodiversity wealth may not be adequately utilized to generate self-sustaining innovation and reposition Latin American countries in international trade. In other words, the region's potential in exporting biodiversity-based products may be largely concentrated in the sale of raw or semi-processed products, which are used as inputs by Center countries. This issue will be investigated in the following subsection.

4.1- Latin American foreign trade and the potential arising from Biodiversity

Figure 02 presents the logarithmic exports of high-tech manufacturing products. It is observed that only Brazil, Argentina, Mexico, and Chile are positioned alongside the Center countries, with

high participation. These countries are exceptions to the standard pattern of the Periphery, as they are the result of massive industrialization policies implemented during the second half of the 20th century, when Import Substitution Industrialization (ISI) was the development model adopted by Latin American countries.

Figure 02 – Characterization of the productive structure, Center versus Periphery, for exports of high-tech manufacturing, 2022

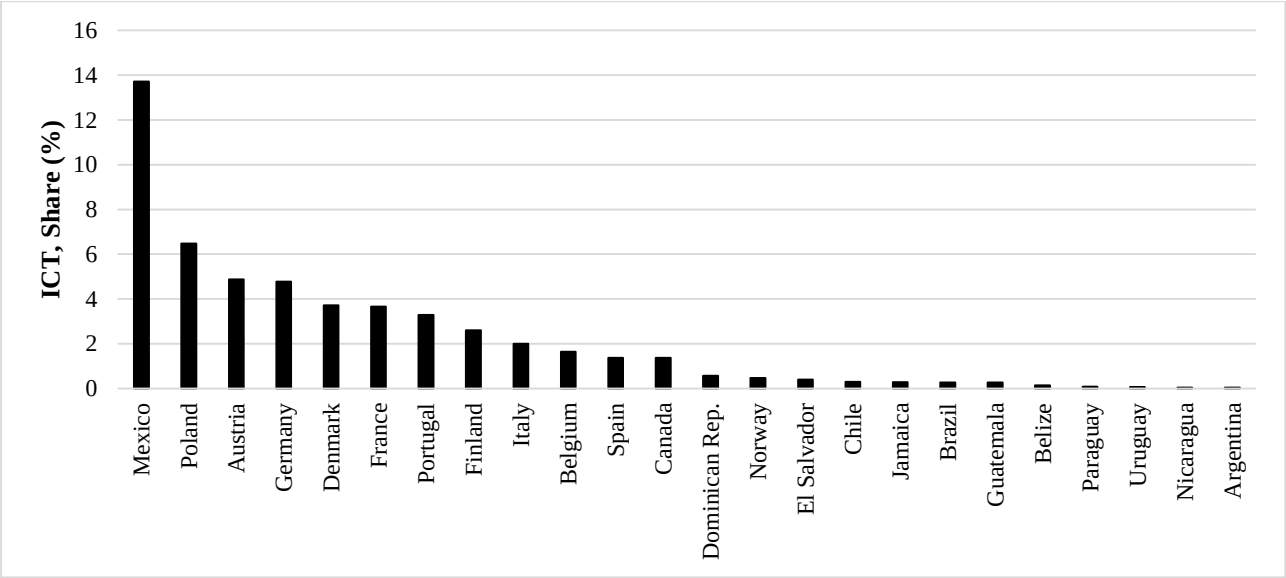


Source: Adapted from Unctad and World Bank

With the advent of deindustrialization, starting in the mid-1980s, Latin American countries were unable to follow the same trajectory as developed countries, which began deindustrializing in the first half of the 1970s. In other words, peripheral countries failed to excel in the export of modern services.

In the case of ICT exports (**Figure 03**), all Center countries, except Mexico (due to the presence of maquilas), show a higher share of this sector in their service exports than the countries of the Periphery. According to Pereira et al. (2023), the reason peripheral countries fail to excel in the export of modern services stems from structural issues that have historically shaped the productive structure of Latin America and the Caribbean. This pattern of peripheral integration of Latin American countries tends to repeat itself over time.

Figure 03 – Characterization of the productive structure, Center versus Periphery, for the participation of ICTs in service exports, 2022.



Source: Adapted from Unctad and World Bank

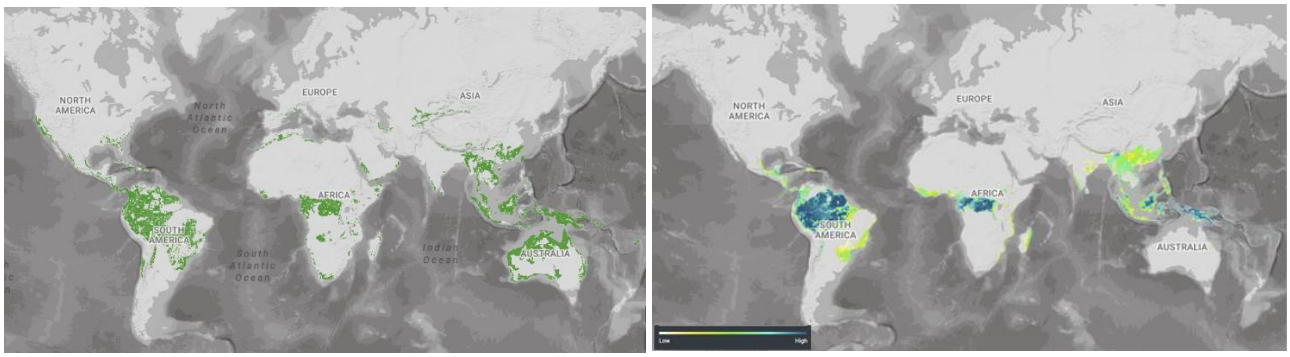
According to the authors, since these countries did not endogenize technical progress during the industrialization phase, the stock of knowledge that is transferred from manufacturing to the modern service sector during deindustrialization is minimal. Therefore, their ability to lead innovation and export competitive modern services remains limited, and Latin American countries perpetuate the Center-Periphery relationship in the context of the service economy (Pereira et al., 2023).

In this context, since Latin American countries find themselves in a peripheral position both in the export of manufactured goods and modern services (ICTs), it is important to identify new opportunities that can promote the economic development of the region by utilizing indigenous production factors. Biodiversity represents a new opportunity to create international competitive advantage, as it is a unique wealth whose content reflects the distinct characteristics of the region.

Figure 04(A) shows that the areas with the greatest biodiversity are tropical regions, where Latin American countries have territories with a relatively high degree of biome preservation. **Figure 04(B)** highlights how these areas can play a strategic role in development, as they possess forest structures with low levels of devastation. This means that a significant portion of the flora and fauna, in addition to being preserved, has the potential for the production of new high-value-added products.

Figure 04 – Biodiversity and forest conservation in regions of the world, 2023
High Biodiversity Areas (A) Forest Structural Condition Index (B)[3]

[3] The Forest Structural Condition Index (SCI) is a metric that measures the structural complexity of a forest. It's used to quantify the height, cover, and disturbance history of a forest's canopy. The SCI is based on the idea that forests with more structural heterogeneity are more ecologically stable and have more species. More detail: Hansen et. al., (2019).



Fonte: UNbiodiversityLab

Thus, since most Latin American countries have areas with a high degree of biodiversity, it is necessary to outline the BioTrade landscape for the region in relation to the world. In this way, it is possible to identify the position of Latin America in the international trade of biodiversity-derived products. The following two subsections provide a detailed analysis of BioTrade globally and in Latin America and the Caribbean, as well as both non-parametric and parametric tests to test the hypothesis of the existence of a Center-Periphery relationship.

4.2-General Characteristics of BioTrade in the World and Latin America and the Caribbean

The BioTrade has increased its share in the national income of countries in Latin America and the Caribbean (**Table 04**). Between 2010 and 2022, the average annual growth rate was 2.11%, with South America standing out with a growth rate exceeding 3%. In this sense, the results suggest that these activities in the region have significant growth potential compared to other regions of the world. Other regions, such as Central Asia (6.95%), Southern Europe (3.52%), and Western Europe (2.02%), also exhibit high growth rates.

Despite the growth observed in these other regions, it is important to emphasize that the wealth of Latin American biodiversity, when compared to other regions of the planet, ensures a near-monopoly position in the biodiversity product market with potential for value addition.

Table 04 - Percentage of Biotrade in the GDP of the regions and growth rate between 2010 and 2022

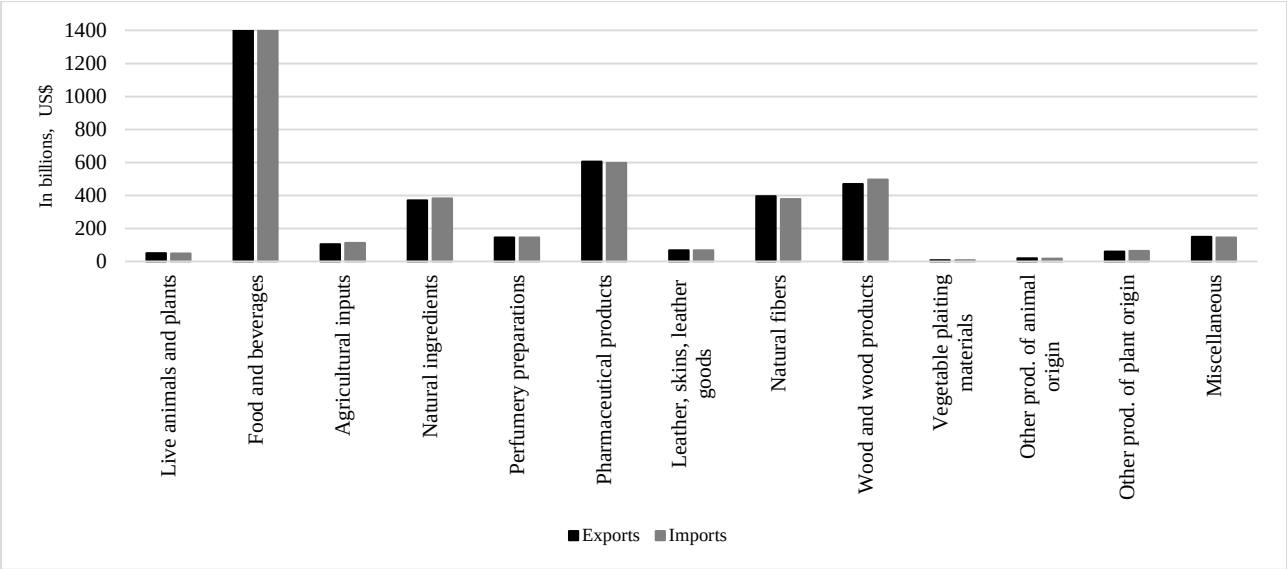
Economies	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Average annual growth rate 2010 - 2022
World	7,27	7,72	7,39	7,53	7,49	7,35	7,23	7,29	7,28	7,15	7,32	7,65	6,86	-0,45
Africa	7,93	9,11	8,22	7,76	7,46	7,72	8,32	8,31	7,79	7,14	6,89	6,9	5,48	-2,80

Northern America	3,76	4,02	3,91	3,9	3,94	3,8	3,74	3,61	3,69	3,58	3,66	3,95	3,94	0,36
Latin America and the Caribbean	6,68	7,27	7,1	7,04	6,79	7,31	7,62	7,4	8,02	8,18	9,53	9,67	8,76	2,11
Caribbean	6,16	6,8	6,85	6,59	6,64	6,39	6,17	6,08	5,94	5,85	5,57	5,53	4,36	-2,62
Central America	8,79	9,56	8,96	8,48	8,18	8,77	9,37	9,27	9,35	9,15	10,02	9,49	8,48	-0,28
South America	6,04	6,59	6,53	6,59	6,33	6,82	7,08	6,83	7,64	7,95	9,67	10,15	9,29	3,37
Asia	6,22	6,48	6,21	6,45	6,33	6,24	5,76	5,82	5,63	5,5	5,4	5,73	4,22	-2,94
Central Asia	3,26	3,54	3,97	3,68	3,55	2,97	3,65	5,82	6,43	6,84	7,18	7,84	7,81	6,95
Eastern Asia	5,06	5,24	4,93	5,06	4,98	4,74	4,42	4,41	4,29	4,21	4,06	4,29	4,16	-1,50
South-eastern Asia	14,92	16,34	15,11	14,77	15,22	14,83	14,45	14,79	14,79	13,91	14,35	15,95	3,17	-11,23
Southern Asia	6,03	6,64	6,1	7,34	6,05	6,85	5,09	5,04	4,42	4,11	3,94	4,45	3,62	-3,85
Western Asia	5,96	5,46	6,38	6,65	7,12	7,65	7,38	7,6	7,41	7,46	8,08	8,09	5,96	0,00
Europe	11,5	12,07	11,92	12,13	12,25	12,54	12,86	13,13	13,13	13,23	13,88	14,23	14,24	1,66
Eastern Europe	9,73	9,57	9,58	9,94	10,69	11,98	12,77	12,27	12,46	12,23	13,43	13,68	9,62	-0,09
Northern Europe	10,64	10,88	10,25	10,48	10,35	10,23	10,54	10,89	10,87	10,74	11,19	10,53	11,13	0,35
Southern Europe	10,49	11,38	11,76	12,16	12,45	12,82	12,99	13,19	13,33	13,63	14,22	15,67	16,45	3,52
Western Europe	13,06	13,96	13,87	13,9	13,78	13,95	14,12	14,59	14,48	14,73	15,29	15,86	16,94	2,02
Oceania	6,31	6,99	6,37	6,52	6,9	7,29	6,87	7,21	7,08	7,34	6,84	7,91	7,13	0,94

Source: UNCTADstat

In **Figure** 05, we detail the main products in the global Biotrade trade for the year 2022. The data show that biodiversity-related product exports are concentrated in a few key products. The most exported products were Food and Beverages, totaling R$ 1.224,17 billion; Pharmaceuticals, R$ 582,6 billion; Wood and Wood Products, R$ 422,52 billion; Natural Fibers and Derivatives, R$ 337,58 billion; and Natural Ingredients, US$ 293,67 billion. These products accounted for 84% of total exports, with Food and Beverages and Pharmaceuticals responsible for 36% and 17%, respectively.

Figure 05 – Global BioTrade exports and imports, by product, 2022 (in billions of US$)

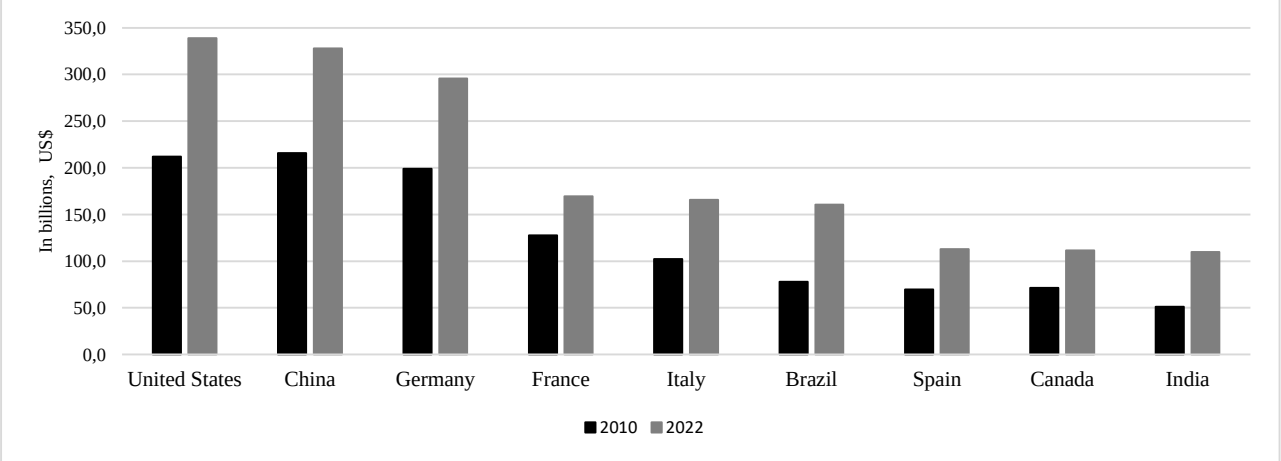


Source: Adapted from Unctad

The countries with the highest exports of BioTrade in 2022 (**Figure 06**) were the United States with US$ 333 billion; China, US$ 318 billion; Germany, US$ 287 billion; and France, US$ 167 billion. Except for China, the other countries have a fully developed manufacturing structure and are therefore capable of performing the minimum processing of raw materials derived from their biodiversity. This is the reason why the U.S. and Europe lead the international trade of biodiversity-derived products (Unctad, 2024).

In the case of developing countries, it is observed that Brazil and India rank sixth and ninth, respectively, with exports of US$ 160 billion and US$ 109 billion. These countries also experienced the highest growth in exports between 2010 and 2022, at 105% and 114%, respectively. This suggests that these countries may capitalize on this comparative advantage to structure a development strategy that intelligently utilizes their biodiversity resources.

Figure 06 – Countries with the largest BioTrade exports, 2010 and 2022 (in billions of US$)

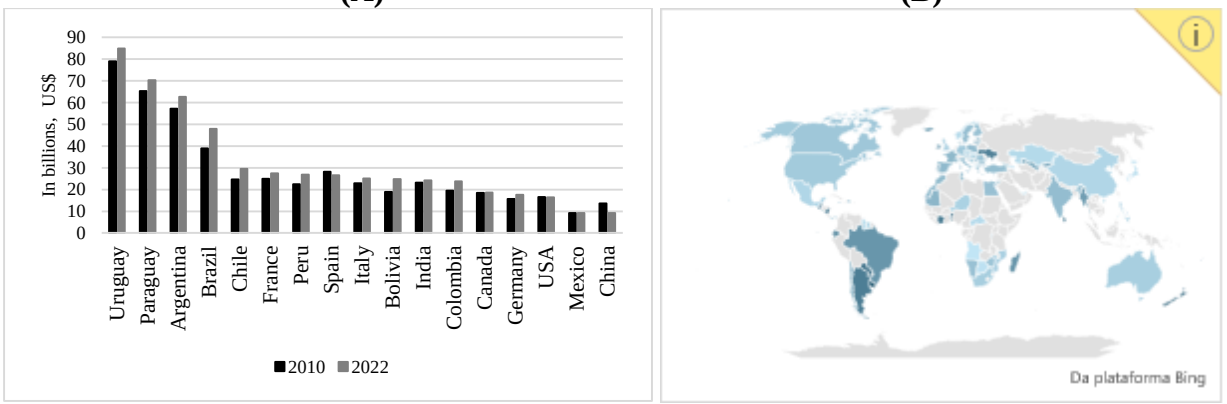


Source: Adapted from Unctad

When selecting data from the nine countries with the highest exports among the leading Latin American and Central countries, as shown in **Figure 07(A)**, it is observed that some Latin American countries, such as Uruguay, Paraguay, Argentina, and Brazil, display a high dependence on the export of products from this category. This dependence is particularly evident due to the increase observed between the years 2010 and 2022. On the other hand, among high-income countries, Spain and France exhibited the highest participation, with 26.32% and 27.08% in 2022, respectively.

Figure 07 – Biotrade, share of total exports to selected countries (%)

(A) **(B)**



Source: Adapted from Unctad; Peru and Bolivia, 2021 data.

Figure 07(B) shows that, with isolated cases such as Ukraine in Europe, Ivory Coast in Africa, and Myanmar in Asia, South American countries (Uruguay, Paraguay, Argentina, and Brazil) exhibit the highest concentration of BioTrade exports. The countries in the Center, despite being among the top exporters, display a low share in total exports.

These results align with the discussion made by ECLAC. The countries in the South American Periphery exhibit high specialization and dependence on the export of products linked to the primary sector. In contrast, the Center countries have a diversified production structure, and although they are the largest exporters of biodiversity-related products, they do not have a high dependence on the revenues from this sector.

This unequal nature of entry into international trade is reinforced by export data, as shown in **Table 05**. Despite the United States and Germany exporting products of low technological intensity, notably in the Food and Beverage sector, which accounts for 36% and 24% of their BioTrade exports, respectively, they also export products associated with high technological sophistication, with Pharmaceuticals accounting for 19% and 35% of their exports, respectively.

Table 05 – BioTrade exports to selected countries, by product group, 2023

	In billions US$				Share			
	USA	DEU	CHN	BRA	USA	DEU	CHN	BRA
Live animals and plants	1,8	2,3	1,9	0,3	1%	1%	1%	0%
Food and beverages	120,9	69,0	66,0	66,0	36%	24%	21%	41%
Agricultural inputs	16,2	5,3	2,9	11,3	5%	2%	1%	7%
Natural ingredients	48,1	15,0	13,4	54,0	14%	5%	4%	34%
Perfumery preparations, cosmetics, care	12,0	10,6	7,5	0,6	4%	4%	2%	0%
Pharmaceutical products	64,6	101,2	11,0	0,8	19%	35%	3%	1%
Leather, skins, leather goods and treated skins	2,6	2,2	9,2	1,3	1%	1%	3%	1%
Natural fibers and derived articles	15,8	17,9	108,9	4,2	5%	6%	34%	3%
Wood and wood products	39,8	43,8	63,0	16,1	12%	15%	20%	10%
Vegetable plaiting materials and articles thereof	0,2	0,1	4,3	0,0	0%	0%	1%	0%
Other products of animal origin	1,3	1,1	6,7	0,6	0%	0%	2%	0%
Other products of plant origin	1,3	3,1	1,0	2,5	0%	1%	0%	2%
Miscellaneous	8,4	15,3	22,4	2,4	3%	5%	7%	2%

Source: Adapted from Unctad

On the other hand, China and Brazil concentrate their exports in products of low technological sophistication. Natural fibers and derivative products account for 47% of China's exports, while Pharmaceuticals account for only 2%. For Brazil, these products represent 51% and 1% of exports, respectively.

The analysis of imports, shown in **Table 06**, reveals that the products with the highest share in imports for the United States and Germany are Food and Beverages, accounting for 33% and 31%, respectively, followed by Pharmaceuticals, at 23% for both countries. These countries display a high import share in products of lower technological intensity. However, they also import substantial quantities of high-tech products, particularly Pharmaceuticals. The significant share of pharmaceutical imports and exports is likely explained by the greater entry into Global Value Chains, indicating a high level of integration and intra-industry trade.

Table 06 – BioTrade imports to selected countries, by product group, 2023

	In billions US$4				Share			
	USA	DEU	CHN	BRA	USA	DEU	CHN	BRA
Live animals and plants	7,76	4,33	1,46	0,06	1%	2%	0%	0%
Food and beverages	182,23	81,30	122,74	11,32	33%	31%	34%	44%
Agricultural inputs	4,63	4,57	8,43	0,57	1%	2%	2%	2%
Natural ingredients	28,82	20,52	86,22	2,82	5%	8%	24%	11%
Perfumery preparations, cosmetics, care	15,26	7,05	22,56	0,53	3%	3%	6%	2%
Pharmaceutical products	129,48	59,81	28,02	6,29	23%	23%	8%	24%
Leather, skins, leather goods and treated skins	9,45	2,75	7,62	0,21	2%	1%	2%	1%
Natural fibers and derived articles	71,78	30,15	19,93	1,09	13%	11%	5%	4%
Wood and wood products	73,77	33,57	52,31	1,48	13%	13%	14%	6%
Vegetable plaiting materials and articles thereof	2,39	0,33	0,11	0,01	0%	0%	0%	0%
Other products of animal origin	2,70	1,36	2,36	0,21	0%	1%	1%	1%
Other products of plant origin	5,34	3,79	5,83	0,63	1%	1%	2%	2%
Miscellaneous	21,77	13,13	6,29	0,65	4%	5%	2%	3%

Source: Adapted from Unctad

China and Brazil primarily import Food and Beverages, with shares of 34% and 44%, respectively. Both also show a significant share of Pharmaceuticals in their imports, at 8% and 24%, respectively. These two product categories, along with Natural Ingredients, account for 66% of

China's imports and 79% of Brazil's imports, highlighting the high concentration of imports in specific products.

Finally, the analysis of the trade balance for Latin America and the Caribbean and the main countries in this region supports the existence of a disadvantageous trade relationship for products derived from biodiversity with higher technological sophistication, as shown in **Table 07**. All countries recorded a deficit in Pharmaceuticals, with most also observing a deficit in Perfumes and Plant Materials.

Table 07 – Latin America and the Caribbean trade balance for BioTrade, by product, 2023

	Total	MEX	ARG	BOL	BRA	CHL	COL	PRY	PER	URY	VEN
Live animals and plants	2,256	0,379	0,010	-0,004	0,685	0,035	1,243	-0,013	0,004	0,135	-1,008
Food and beverages	63,863	2,064	12,963	-0,009	31,529	7,440	1,558	1,043	1,458	2,547	-2,439
Agricultural inputs	12,406	-1,253	9,166	0,320	4,979	0,250	-0,657	0,353	1,248	-0,067	-0,961
Natural ingredients	17,668	-4,785	10,017	0,301	12,008	-0,027	-0,619	1,881	-0,153	0,653	-0,879
Perfumery preparations	-1,299	0,716	0,084	-0,093	0,008	-0,462	0,116	-0,149	-0,225	-0,081	-0,372
Pharmaceutical products	-11,790	-1,919	-0,767	-0,068	-3,496	-0,366	-0,705	-0,048	-0,290	-0,042	-1,850
Leather, skins, leather goods	2,948	-0,241	1,024	0,032	1,840	-0,036	0,169	0,095	0,009	0,166	-0,020
Natural fibers	-0,199	0,503	-0,031	0,008	0,032	-1,007	-0,158	-0,029	0,693	0,055	-0,599
Wood and wood products	0,286	-5,490	-0,476	-0,033	6,911	3,742	-0,568	-0,091	-0,603	0,323	-0,735
Vegetable plaiting materials	-0,074	-0,005	-0,001	0,000	-0,012	-0,008	-0,006	0,000	-0,005	-0,002	-0,005
Other prod. of animal origin	0,244	-0,131	0,057	-0,002	0,287	0,014	-0,015	0,018	-0,017	0,048	0,006
Other prod. of plant origin	1,951	-0,134	0,088	-0,008	1,890	-0,016	-0,042	-0,130	-0,036	-0,005	-0,052
Miscellaneous	-0,265	-1,056	1,097	0,015	1,332	-0,513	-0,227	-0,036	-0,201	-0,070	-0,150

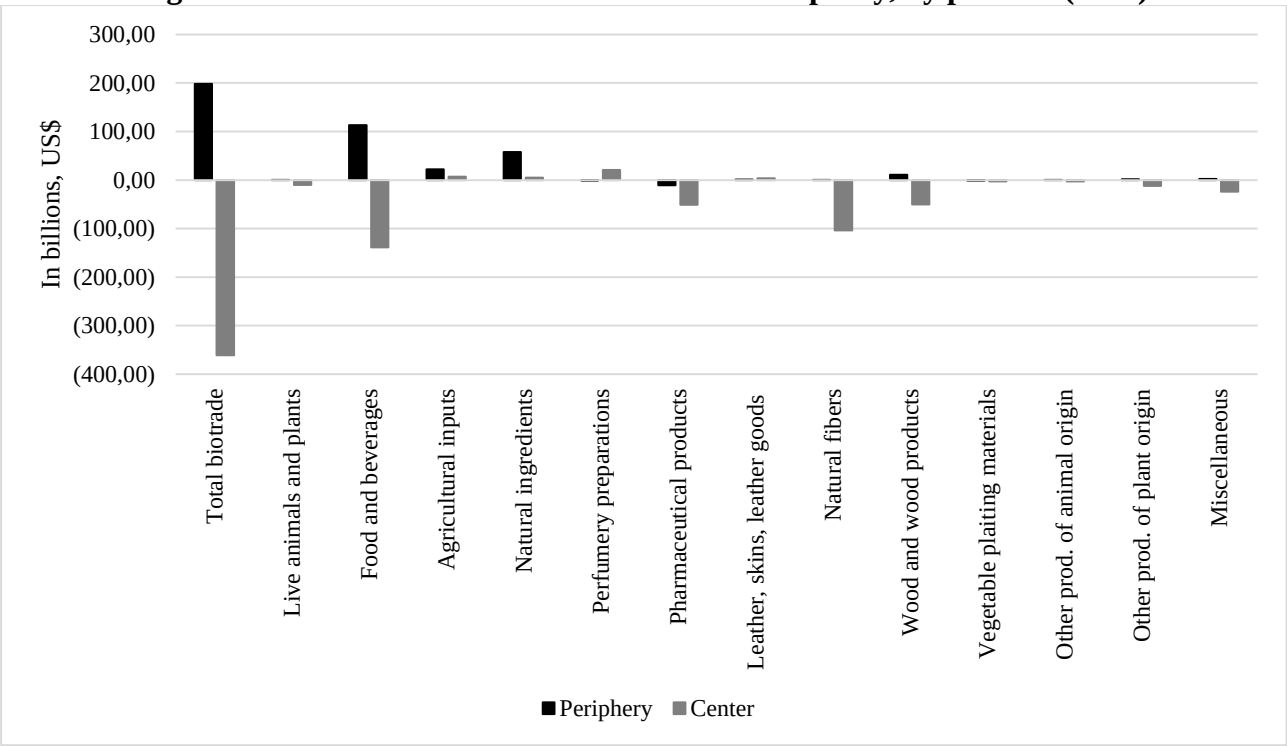
Source: Adapted from Unctad

4.3-The Center-Periphery relationship and the deterioration of the terms of trade in Biotrade

To carefully analyze the issue of the Center-Periphery relationship and the determination of the terms of trade in Biotrade, we compiled a special aggregation of countries, considering the Center as composed of G7 countries (United States, Japan, Germany, United Kingdom, France, Italy, and Canada), and the Periphery as consisting of Latin American countries with the highest Biotrade exports (Brazil, Argentina, Mexico, Bolivia, Paraguay, Uruguay, and Chile).

As shown in **Figure 08**, the Center exhibits a high trade deficit in Food and Beverages, US$ -139.10 billion compared to the rest of the world; Natural Fibers and Derived Products, US$ -104.02 billion; Pharmaceuticals, US$ -51.17 billion; and Wood and Derived Products, US$ -50.52 billion. The trade balance is positive only in Perfume Preparations, Cosmetics, and Personal Care, US$ 20.81 billion; Agricultural Inputs, US$ 6.65 billion; Natural Ingredients, US$ 5.06 billion; and Leather, Hides, Leather Articles, and Processed Skins, US$ 3.89 billion. As expected, the high degree of industrialization in these countries results in a demand for raw materials and inputs, which explains the deficit in the Biotrade sector.

Figure 08 – Trade balance of the Center and Periphery, by product (2022)

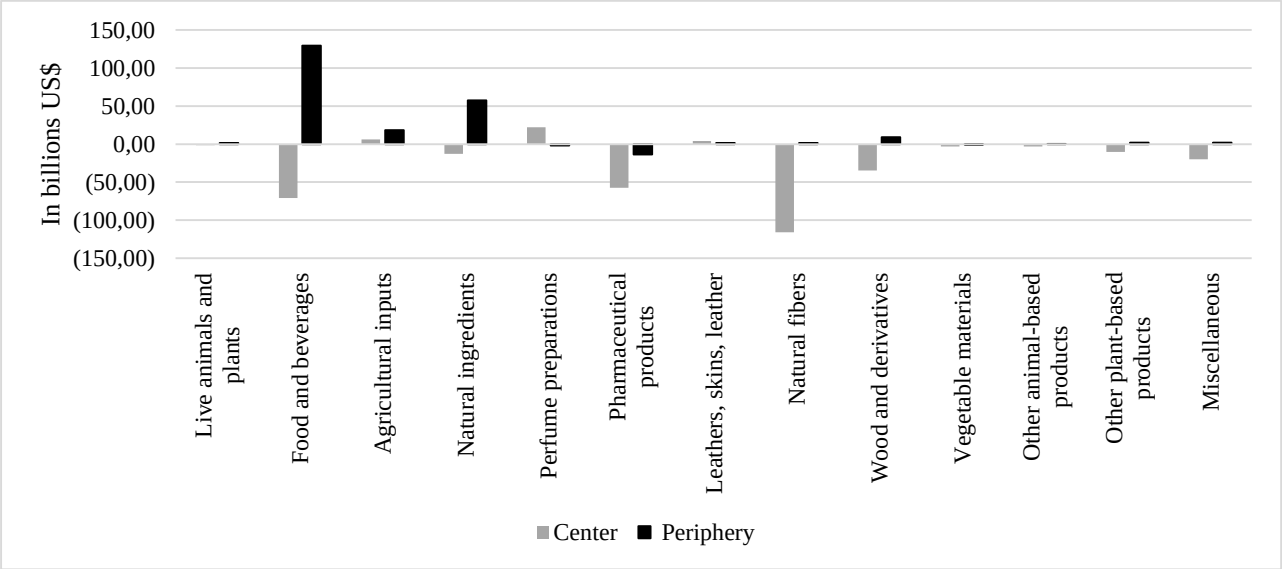


Source: Adapted from Unctad

On the other hand, the Periphery records a trade surplus primarily in Food and Beverages, US$ 113.35 billion; Natural Ingredients, US$ 57.54 billion; and Agricultural Inputs, US$ 21.92 billion. It registered a trade deficit in Pharmaceuticals, US$ -10.75 billion; Perfume Preparations, Cosmetics, and Personal Care, US$ -0.58 billion; and Vegetable Materials, US$ -0.08 billion. Despite the deficit in products with higher technological intensity, these countries show a trade surplus in Biotrade. This suggests that the advantages associated with the abundance of natural resources offset the lower technological development.

When a less strict classification is used, which considers the Periphery to include all Latin American countries and the Center to include the 16 high-income countries, as shown in **Figure 09**, the Center now exhibits a trade deficit in Pharmaceuticals, largely due to the significant deficits recorded by the United States and Japan. The Center shows a trade surplus only in Agricultural Inputs, Perfume Preparations, and Leather, Hides, and Leather Articles. In contrast, the Periphery does not show a trade surplus only in Perfume Preparations, Pharmaceuticals, and Vegetable Materials.

Figure 09 – Trade balance of the Center and Periphery, by product (2022), less rigorous aggregation



Source: Adapted from Unctad, Periphery: Uruguay, Paraguay, Nicaragua, Mexico, Jamaica, Guyana, Guatemala, Grenada, El Salvador, Dominican Republic, Ecuador, Chile, Brazil, Belize, Barbados, Argentina. Center: United States, United Kingdom, Spain, Portugal, Poland, Norway, Netherlands, Japan, Italy, Germany, France, Finland, Denmark, Canada, Belgium and Austria.

Statistical tests were conducted and are summarized in **Table 08**. The Levene Test shows that Agricultural Inputs and Pharmaceuticals do not exhibit constant variance, and therefore, the non-parametric Mann-Whitney test should be used to verify whether the means for the VCR indicator are equal between the countries of the Center and the Periphery. The t-test for equality between two independent samples shows that for Food and Beverages and Natural Ingredients, peripheral countries have a higher mean for the VCR indicator, while for Live Animals and Plants, Perfume Preparations, Pharmaceuticals, Natural Fibers and Derived Products, Wood and Derived Products, and Miscellaneous, central countries have a higher mean. This result is further corroborated by the Mann-Whitney test for Pharmaceuticals.

Table 08 - Mean equality test for the VCR indicator, strict classification

Products	Levene	p-valor	Teste t	p-valor	Mann-Whitney	p-valor
Live animals and plants	0,674	0,429	2,906*	0,017	39*	0,012
Food and beverages	1,624	0,229	-3,817*	0,005	1*	0,002
Agricultural inputs	4,866*	0,050	-1,376	0,225	17	0,628
Natural ingredients	3,198	0,101	-2,057**	0,085	13	0,295
Perfumery preparations	1,854	0,201	2,514*	0,041	38*	0,018
Pharmaceutical products	6,663*	0,026	5,278*	0,002	42*	0,003
Leather, skins, leather goods	1,401	0,262	1,282	0,244	25	0,628
Natural fibers	0,328	0,578	2,319*	0,043	33,5*	0,086
Wood and wood products	0,402	0,539	1,083	0,306	31	0,181
Vegetable plaiting materials	1,331	0,273	1,917	0,103	41*	0,005
Other prod. of animal origin	0,229	0,642	0,102	0,920	25,5	0,567
Other prod. of plant origin	0,383	0,549	-0,554	0,594	17	0,628
Miscellaneous	0,109	0,748	2,347*	0,039	36*	0,035

Source: The authors, *Significant at 95%

The mean equality test conducted between the 16 Latin American countries and the 16 highest per capita income countries in the sample, as presented in **Table 09**, confirms the results of other

tests. Considering the t-test, it is observed that the Periphery exhibits a higher Revealed Comparative Advantage (RCA) in Food and Beverages, while the Center shows a higher RCA in Preparations and Perfume. Regarding the Mann-Whitney test, the Center demonstrates a higher RCA in Pharmaceuticals and Miscellaneous products.

Table 09 - Mean equality test for the VCR indicator, Latin America

Products	Levene	p-valor	Teste t	p-valor	Mann-Whitney	p-valor
Live animals and plants	0,821	0,372	1,343	0,190	179*	0,057
Food and beverages	1,987	0,169	-4,034*	0,000	37*	0,000
Agricultural inputs	2,239	0,145	-0,806	0,431	172	0,101
Natural ingredients	3,562	0,069	-1,098	0,287	153,5	0,346
Perfumery preparations	3,102	0,088	2,677*	0,016	217*	0,001
Pharmaceutical products	16,528*	0,000	4,488*	0,000	240*	0,000
Leather, skins, leather goods	2,149	0,153	2,110*	0,050	197,5*	0,009
Natural fibers	2,172	0,151	-0,602	0,555	171,5	0,105
Wood and wood products	1,038	0,317	2,052*	0,054	190*	0,020
Vegetable plaiting materials	0,106	0,748	0,951	0,350	231*	0,000
Other prod. of animal origin	0,111	0,741	2,334*	0,026	204*	0,004
Other prod. of plant origin	0,674	0,418	-0,787	0,438	120	0,777
Miscellaneous	3,722*	0,063	4,007*	0,000	222*	0,000

Source: The authors, *Significant at 95%.

Therefore, the mean and median equality tests for RCA confirm that Latin American peripheral countries exhibit RCA primarily in products with lower technological sophistication, to the detriment of more sophisticated goods. This finding reinforces the existence of an international division that assigns these countries a subordinate position in foreign trade.

The pooled and panel regressions with random effects, estimated for Latin American countries and the 16 high-income Center countries, further corroborate this result (**Table 10**). The Hausman test indicates that the regression should be estimated with random effects, while the Breusch-Pagan test reveals the presence of heteroskedasticity in the pooled model, which is therefore estimated with robust errors. The binary variable included for the Center countries is statistically significant and demonstrates that these countries export a higher proportion of pharmaceutical products relative to total BioTrade exports compared to the peripheral countries.

Table 10 – Estimated regressions for the proportion of exports of pharmaceutical products

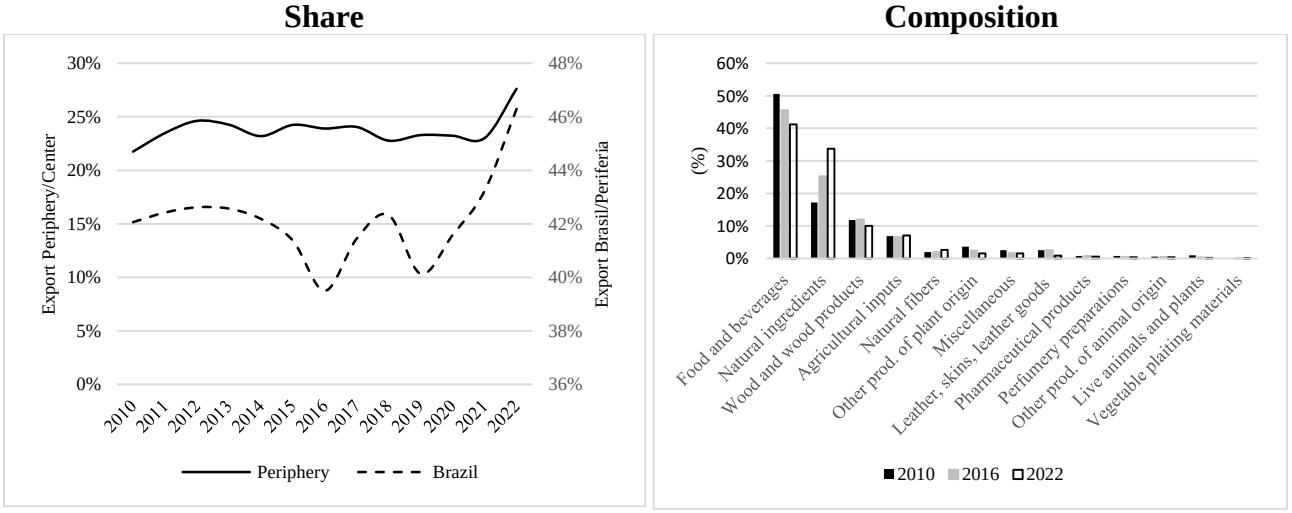
	OLS		**Panel**	
Variable	**Coef.**	**E.P.**	**Coef.**	**E.P.**
Center	0,112*	0,007	0,028*	0,028
Intercept	0,026*	0,004	0,065*	0,065
R^2	0,362	-	-0,117	-
R^2 within	-	-	0,118	-
R^2 between	-	-	0,056	-
Hausman	-	-	0	1,000
Breusch-Pagan	40,23*	-	0	-

Source: result of estimates. *Significant at 95%.

Finally, **Figure 10** provides a proxy for the relative deterioration of the terms of trade. Specifically, it depicts the share of Peripheral countries' exports in relation to the exports of the Center. In 2010, the Periphery accounted for 22% of the Center's exports, a figure that rose to 23% in 2021 and saw a significant increase to 28% in 2022. This trajectory indicates a positive trend for the Periphery throughout the period under analysis. However, as previously discussed, this growth is primarily driven by exports of low-value-added products. This suggests that the income transferred to peripheral countries remains below the potential level that could be achieved under conditions of exporting biodiversity products with higher value addition.

It is also noteworthy that the increase in the Periphery's share is mainly attributable to the growth of Brazilian exports. In 2010, Brazil accounted for 42% of the Periphery's exports, with its share declining to 39% in 2016 and 40% in 2019, after a temporary rise to 42% in 2018. From 2019 onward, Brazil's share demonstrated consistent growth, reaching 46% in 2022.

Figure 10 – Share of the Periphery and Brazil in the Center's exports and composition of Brazilian exports (%)



Source: The authors.

A more detailed analysis of the composition of Brazilian exports reveals a significant increase in the share of Natural Products, rising from 17% in 2010 to 34% in 2022, while the share of Food and Beverages declined from 51% in 2010 to 41% in 2022. Furthermore, the participation of more technology-intensive products, although already low, decreased even further over the analyzed period. In 2010, only 0.8% of Brazil's BioTrade exports consisted of Pharmaceutical Products, a proportion that fell to 0.5% in 2022. Similarly, exports of Perfumery, Cosmetics, and Care Preparations represented 0.7% in 2010, decreasing to 0.4% in 2022.

These findings suggest that Brazil's relative improvement in its trade balance during the analyzed period should be interpreted with caution, as it is linked to a growing reliance on exports of

low-technology products at the expense of more sophisticated ones. In the framework proposed by Prebisch and Cabañas (1949), this trend highlights an increase in external dependency and internal vulnerability to international dynamics**.**

5.Concluding remarks

The objective of this article was to analyze the foreign trade of biodiversity-based products (BioTrade) from a Latin American structuralist perspective and propose economic policy recommendations. The descriptive statistics reveal the division between central and peripheral countries in the trade of biodiversity-derived products. The Center demonstrates higher export volumes of more sophisticated products, such as pharmaceuticals and perfumery, cosmetics, and personal care items. Conversely, the Periphery records trade surpluses, particularly in food and beverages, natural ingredients, and agricultural inputs, reflecting its lower technological sophistication.

Although the Center exhibits higher exports of BioTrade products, it also displays significant diversification in its export matrix, with low dependency on exports from this sector. On the other hand, the Periphery not only stands out for exporting less technologically sophisticated products, even within BioTrade, but also shows a high dependency on these exports, with an undiversified export structure. These outcomes reflect the Periphery's subordinate position within global value chains and its specialization in primary products.

The proxy for the relative deterioration of the terms of trade indicates a positive trajectory for the Periphery's participation during the analyzed period. However, as previously discussed, the predominance of low-value-added products suggests that the income transferred to peripheral countries remains below what could be achieved under conditions of exporting biodiversity products with greater value addition. These countries' reliance on the export of products from this sector to maintain external equilibrium underscores this dynamic.

The results of the independent samples t-test and the Mann-Whitney test indicate that Periphery countries display higher Revealed Comparative Advantage (RCA) values for less technologically advanced products, whereas Center countries demonstrate superior performance in more advanced goods. The regression estimates further corroborate this pattern. The binary variable added for central countries is statistically significant, indicating a higher share of pharmaceutical products in their exports compared to peripheral countries.

The historical absence of endogenous technical progress explains the observed outcomes. Under these conditions, the opportunity window provided by the richness of biodiversity in Latin American countries is underutilized, leaving room for BioTrade to also align with the terms of the Center-Periphery relationship. In other words, the Center-Periphery dynamic is also evident in the trade of biodiversity-derived products.

As an economic policy recommendation, it is essential for Periphery countries to adopt public policies that encourage the development of new products and technologies. Establishing research centers specializing in biotechnology can foster innovation in the sector. Furthermore, implementing tax incentives for companies investing in Research and Development (R&D), particularly those aligned with the sustainable use of biodiversity, is critical. Strengthening public-private partnerships in the health and pharmaceutical sectors can also bridge efforts between government and private enterprise.

These strategic actions can significantly contribute to mitigating Latin America's disadvantaged position, fostering important advancements in the region's productive structure. Economic development strategies should focus on productive development policies that add value to bioeconomy products and promote the creation of a bioindustry with endogenous technical progress. Encouraging economic activities related to biodiversity without integrating them into national manufacturing strategies is merely a more sophisticated way of ensuring the inclusion of Latin American countries as the Periphery within the traditionally established global structure.

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