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DECARBONIZATION AND INDUSTRIAL POLICY: CHALLENGES FOR BRAZIL

Working Paper DIP-BR 03/2024

Policy intervention towards low carbon enabling products: do countries differ?

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About the Project DIP-BR

"Decarbonization and Industrial Policy: Challenges for Brazil" (DIP-BR) is a policy-oriented research-action project aimed at influencing public debate on industrial, innovation, and trade policies in Brazil and selected Latin American countries that promote decarbonization and energy transition in the region. The initiative seeks to inform and induce efficacy, efficiency, effectiveness, and innovativeness in policy design and implementation. The methodology encompasses critical benchmarking analyses of past and present policy experiences from an international comparative perspective, regional trade studies, and economic analyses of productive sectors and chains, combining structural analysis of traditional production, employment, and trade statistics and simulation models of sectoral impacts using input-output approach.

Funded by the Open Society Foundations (OSF), Project DIP-BR is executed by the Research Group of Industry and Competitiveness at the Institute of Economics, Federal University of Rio de Janeiro (GIC/IE-UFRJ, **https://www.ie.ufrj.br/gic**) and is currently managed through José Bonifácio University Foundation (**https://www.fujb.ufrj.br/**).

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POLICY INTERVENTION TOWARDS LOW CARBON ENABLING PRODUCTS: DO COUNTRIES DIFFER?

ABSTRACT

This article presents an exploratory comparative analysis of most relevant instruments of intervention used by a selected group of countries to foster or protect low carbon enabling products (LCEP) between January 2008 and June 2024. Our guiding question is whether public interventions are similar or different in terms of country, instruments of intervention, and targeted products. The article examines five instruments (Financial Grants, Trade Finance, State Loans, Import Tariffs and Export Bans) implemented by the ten most active countries in applying each of them to protect or foster LCEP. The study employs data extracted from the Global Trade Alert database and relies on the definition of low carbon enabling products from a list proposed by the International Monetary Fund. Policy-wise, our evidence shows that countries differ concerning the preferred instruments of intervention to foster or protect the local production of low carbon enabling goods. Country differences can be noted in at least four aspects: (i) their specialization or diversification in the use of specific instruments, (ii) their share in the total use of each instrument, (iii) the intensity of their intervention, and (iv) how each Country´s intervention pattern changes over time.

KEYWORDS

State intervention. Green industrial policy. Decarbonization of industry.
Low carbon products.

JEL CODES L52. Q55. L60.

INTERVENÇÃO DE POLÍTICAS PARA PRODUTOS HABILITADORES DE BAIXO CARBONO: OS PAÍSES DIFEREM?

RESUMO

Este artigo apresenta uma análise comparativa exploratória dos instrumentos de intervenção mais relevantes utilizados por um grupo de países selecionados para promover ou proteger produtos habilitadores de baixo carbono (PHBC) entre janeiro de 2008 e junho de 2024. A questão orientadora do artigo é se as intervenções públicas são semelhantes ou diferentes em termos de país, instrumentos de intervenção e PHBC. O artigo examina cinco instrumentos (Subvenções Financeiras, Financiamento ao Comércio Exterior, Empréstimos Públicos, Tarifas à Importação e Proibição de Exportação) implementados pelos dez países mais ativos em cada um desses instrumentos. A fonte de informação utilizada é a base de dados Global Trade Alert e a definição dos produtos habilitadores de baixo carbono adotada se aproxima da classificação proposta pelo Fundo Monetário Internacional. As evidências mostram que os países diferem em termos dos instrumentos utilizados para promover ou proteger a produção local de produtos indutores de baixo carbono, considerando pelo menos quatro aspectos: (i) especialização ou diversificação no uso de diferentes instrumentos, (ii) participação no uso total de cada instrumento, (iii) intensidade da intervenção e (iv) as mudanças nos padrões de intervenção dos países ao longo dos anos.

PALAVRAS-CHAVE

Intervenção estatal. Política industrial verde. Descarbonização da indústria. Produtos de baixo carbono.

CLASSIFICAÇÃO JEL L52. Q55. L60.

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Introduction

The low-carbon journey has become a global priority to mitigate climate change's negative impacts and increase the probability of a sustainable future. However, recent research at GIC/IE-UFRJ (Peres *et al.* 2024) underlines that such journey is not uniform. Across nations, decarbonization is specific to sectors, places, and moments in time, with significant variations considering viable technological, economic, and social solutions. From economic and technological perspectives, some low-carbon solutions are incremental, easily adaptable to localized economic systems, and primarily associated with increasing costs and environmental efficiencies. Others, however, are radical, implying the overhaul of existing operational facilities with sunk-cost consequences. Some solutions already have market acceptance, others are on an emerging trajectory, while many fields are still awaiting further scientific and technological advances.

From such a panorama, one can derive two implications. First, as in any innovation process, regardless of the stage of development or degree of innovation, low-carbon solutions require significant capabilities. Implementing them requires more than decisions involving suppliers and users seeking competitive advantages. They entail a complex network of direct and indirect social, economic, and environmental implications alongside the externalities accompanying these innovations. Second, government intervention is essential because of a double challenge market forces cannot resolve; on the one hand, correcting the involved negative externalities, e.g. carbon emissions; on the other, reducing and managing uncertainty surrounding the technical and economic feasibility of many technological solutions. Questions like "Which technological route?" and "How to promote a rapid deployment of low-carbon enabling products?" emerge as relevant.

The argument for an active role of the State in the greening of the economy (despite different terminology nuances) is increasingly put forward by authors from various conceptual and theoretical perspectives (Acemoglu *et al.*, 2012; Rodrik, 2014; Mazzucato; Kattel; Ryan-Collins, 2020; Stern; Stiglitz, 2023). The proliferation of intellectual contributions goes hand in hand with the emergence of proactive State policies in countries around the world, to face the threats from climate change, regardless of the political orientation of each administration.

Political decisions and policy directives are influenced by political leaders' perceptions and visions, as well as societal pressures, needs, interests, and aspirations that advocate for proactive State actions. Even so, just as low-carbon journeys are specific to sectors, places, technologies, and moments of time, would public interventions also be specific to countries, types of intervention instruments, and targeted low-carbon products?

In this sense, this paper draws a comparative analysis of intervention instruments used by countries to foster or protect low carbon enabling products **(LCEP)**[1] from January 2008 to June 2024. The primary purpose is to examine how the modes of intervention related to such products vary across selected proactive countries in the considered period. The study explores data extracted from the Global Trade Alert (GTA, 2024b), which allows for analyzing regularities and variations in public policies and identifying patterns and trends that can inform future decarbonization strategies. By investigating trade interventions, this study explores the efficacy dimension of policymaking, seeking to understand the different approaches countries take towards decarbonization, considering the intervention instruments to protect or foster local low carbon enabling products. By shedding light on national approaches to intervention, it may provide insights to aid the design of effective and adaptable policies capable of meeting each country's specific needs while contributing to global sustainability goals and carbon emission reduction efforts.

The structure of this article is straightforward. The first section discusses modes of policy intervention in terms of industrial policy instruments, with a view to set up the frame of reference. The following section presents the methodology and data sources used in the subsequent section, which is dedicated to an analysis of descriptive statistics. The last section summarizes the main findings and suggests a general outline for a research program.

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[1] For a detailed definition of low-carbon enabling products, see Box 1 below.

1. Industrial policy and instruments of intervention

Industrial policies are designed to affect the allocation of inter- and intra-industrial resources and influence the structure, conduct, and performance of economic agents through mobilizing incentive, regulatory, and/or technical assistance instruments. Whether dormant during certain periods or a shining star in others, industrial policy as a relevant research and policy matter never disappeared. Different schools of economic thought and reasoning (market failures, social costs, "nascent or infant industry", etc.) support active public policies aimed at industrial development.

1.1. Recent industrial policies

The strong reemergence of proactive industrial policies in countries around the world in the 2020s, regardless of the political orientation of each administration, is a phenomenon not registered for quite a long time **(Chart 1)**. Behind it lies a set of interrelated impelling

Chart 1- Recent industrial policies in selected countries and regions

Country/Region	Date of policy issue	Policies
United States	2021~24	Infrastructure Investment and Jobs Act (The United States of America, 2021), Chips and Science Act (The United States of America, 2022b), Inflation Reduction Act (The United States of America, 2022a), DOE Investments in Industrial Decarbonization (U.S. DOE..., 2024)
United Kingdom	2021	Net Zero Strategy (HG Government, 2021), UK Innovation Strategy (Government of the United Kingdom, 2021)
European Union	2018~24	Bioeconomy Strategy (European Commission, 2024), NextGenerationEU (European Union, 2024a), Horizon Europe (European Union, 2024a), Green Deal Industrial Plan (European Commission, 2023a), Net Zero Industry Act (European Commission, 2023b)
Japan	2020	Green Growth Strategy Through Achieving Carbon Neutrality in 2050 (Japan, 2021)
China	2021	Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality (People's Republic of China, 2021)
Republic of Korea	2021	Korean New Deal: National Strategy for a Great Transformation (Republic of Korea, 2020)
Germany	2018~23	Special Climate and Transformation Fund (Germany, 2024), National Hydrogen Strategy (Germany, 2023)

Source: Own elaboration.

factors: escalating international competition, the pandemics, harsh geopolitical conflicts, the emergence of disruptive technologies, and, with increasing narrative relevance, the threats from climate change. Political decisions and policy directives are taken up by perceptions and visions of political leaders in association with societal needs, interests, and aspirations pressing State actions in multiple directions. These decisions and directives are backed up and supported by intellectual contributions that organize conceptual pillars under frameworks of reference with a narrative justifying the different modes of State intervention.

Although the strategic objectives vary because of each region's specificities, the plans in Table 1 share a few attributes. They build on a broader understanding that structural change of economies cannot neglect sustainability, and that science, technology, and innovation will be key pillars of development strategies, mainly because of the need for more efficient technologies in mitigating the effects of climate change. However, it is unclear how countries organize their industrial policy actions and the relevant instruments they implement. Moreover, it is necessary to investigate whether countries follow similar patterns of intervention or whether they significantly differ.

1.2. Instruments of intervention

Based on a quantitative and qualitative literature review covering the 1976-2023 period, Peres *et al*. (2024) show a well-defined space for policy intervention in the most cited and influential academic papers on green industrial policy. More than two-thirds of the reviewed literature propose strengthening *regulatory frameworks* or standards, frequently those related to carbon-intensity constraint policies or general environment protection. Many analyze regulations associated with fostering a carbon pricing/market, while others point to compulsory measures to curb *"ecodelinquent"* behaviors. Although regulation strengthening is a consensual policy instrument, authors do not generally agree on the intensity and characteristics it should have. Other widely proposed instruments are *fiscal incentives*, both under the form of targeted subsidies and grants, which are present in more than half of the reviewed studies. In some cases, instruments are viewed as means to correct market failures; in others, they are considered crucial for a market-shaping State intervention. However, few articles propose specific tax or public procurement programs.

About a third of the reviewed studies reviewed propose *fiscal incentives* for fostering innovation, including technological research and development, technical assistance, or technology transfer programs. In some cases, incentives should be targeted at investment in innovation projects. Green finance plays a crucial role in some proposals. A similar share of papers stresses the relevance of *human and institutional capacity building* as a crucial component of policy implementation. Fostering implementation demands other instruments such as public-private partnerships (including civil society organizations), multi-stakeholder engagement, and industrial symbiosis (a concept close to that of production clusters). Most of the reviewed literature highlights the need for improving policy coordination and sequencing within an integrated approach and enhancing monitoring and evaluation systems to ensure transparency of policy goals and outcomes. Even so, studies on the subject tend to be more generic and less detailed when dealing with the implementation dimension of industrial policies.

In the context of the revival of industrial policies, this advance in knowledge suggests the need for efforts to understand further the dynamics and the logic of interventionist policies and their instruments. The analysis of policy experiments should go beyond considering the nature of plans, resource mobilization, and the pertinence of intended goals in the face of development challenges to include other relevant factors, such as the policy implementation stage of policymaking. For that, three dimensions must be subject to urgent attention: the efficacy, efficiency, and effectiveness dimensions of policy actions. Efficacy is the ability to implement an intended policy measure; efficiency is achieving an objective by mobilizing resources in the best way possible; effectiveness represents the outcomes of efforts to produce an intended goal. The unbundling of these dimensions demands significant conceptual and empirical efforts, and it is an urgent task for an adequate understanding and assessment of industrial policy attempts and, more importantly, to bring to fore sufficient evidence to support policymakers in their endeavor to put in motion consequential State actions.

2. Methodological procedures

This article is an exploratory comparative analysis of the implementation of instruments, by countries, towards a selected group of industrial products. We will attempt to qualitatively associate different instruments to different sets of products, calling the attention to countries that significantly mobilize one or another instrument. By doing so we can qualitatively assess whether countries act uniformly or if they differ in implementing industrial policy-related instruments. This study relies on descriptive statistics derived from one of the few systematic, standardized and comparable sources of information, the Global Trade Alert where it is registered the number of State actions in the fostering or protection of products. Thus, this is an attempt to go beyond the content analysis of policy proposals to bring to light, in a novel but exploratory manner, one specific and relatively unknown angle of industrial policies: the implementation dimension of State actions.

2.1 The Global Trade Alert database

The following analysis is based on data extracted from the Global Trade Alert (GTA, 2024b), which systematically collects, manages, and makes available a database of governments' interventions worldwide, primarily concerned with trade-related mechanisms since 2008 (Evenett, 2009). This database is constantly updated according to the announcement date of a given policy intervention, backed by an official statement from an **acting institution**[2]. The database includes information on 16 variables such as government acts, categories of interventions, implementation dates, whether interventions remain active or not, removal dates, implementing jurisdiction, affected jurisdiction, and affected products. Notably, the database provides quantitative information about the number and kind of actions countries take on specific products.

[2] Information about GTA's methodology can be found in the GTA Handbook (Evenett; Fritz, 2022). The GTA database excludes coordinated actions under bilateral trade agreements or the multilateral trading system, i.e., actions considered uncontested, such as Sanitary and Phytosanitary Measures and Technical Barriers to Trade (TBT) or trade agreements under WTO.

Figure 1 presents a simplified scheme of how the database is organized according to the kind of intervention instrument implemented by a given country (original jurisdiction) affecting a set of products that, in turn, can potentially impact several other countries. Annex 1 provides the specification of GTA types of intervention. Thus, interventions applied by originating jurisdictions may affect one jurisdiction or more, with rules applied to one product or more. These interventions may stem from different levels of government agencies and are applied by an implementing **jurisdiction**[3], or more than one in the case of **supranational action**[4].

Figure 1 – GTA's information flow registry

Source: Own elaboration.

GTA classifies intervention instruments based on Unctad's international classification of non-tariff measures (Unctad, 2019). Given Unctad's broad definition of non-tariff measures, the database captures information not only about instruments of intervention strictly associated to foreign trade policy, but also about some of those in the core of industrial policy strategies, such as financial grants or **State loans**[5]. Thus it has been used for other informational and analytical purposes beyond trade issues, as shown by Juhász *et al.* (2022) in the field of industrial policy. Evenett *et al.* (2024) goes further by creating, in a collaboration between GTA and the IMF, the "New Industrial Policy Observatory" (GTA, 2024a), where data are further refined and extracted from the database for the monitoring of industrial policy initiatives since 2023.

[3] The GTA uses the term "Implementing Jurisdiction"; however, we will refer to it as "Originating Jurisdiction" for ease of communication throughout the study. Jurisdictions include other administrative regions, such as overseas territories, the State of Palestine, and not just UN participating countries.

[4] Announcements from supranational organizations (with binding consequences for their member states) are broken down according to the implementing/originating jurisdictions, such as an action by the European Commission.

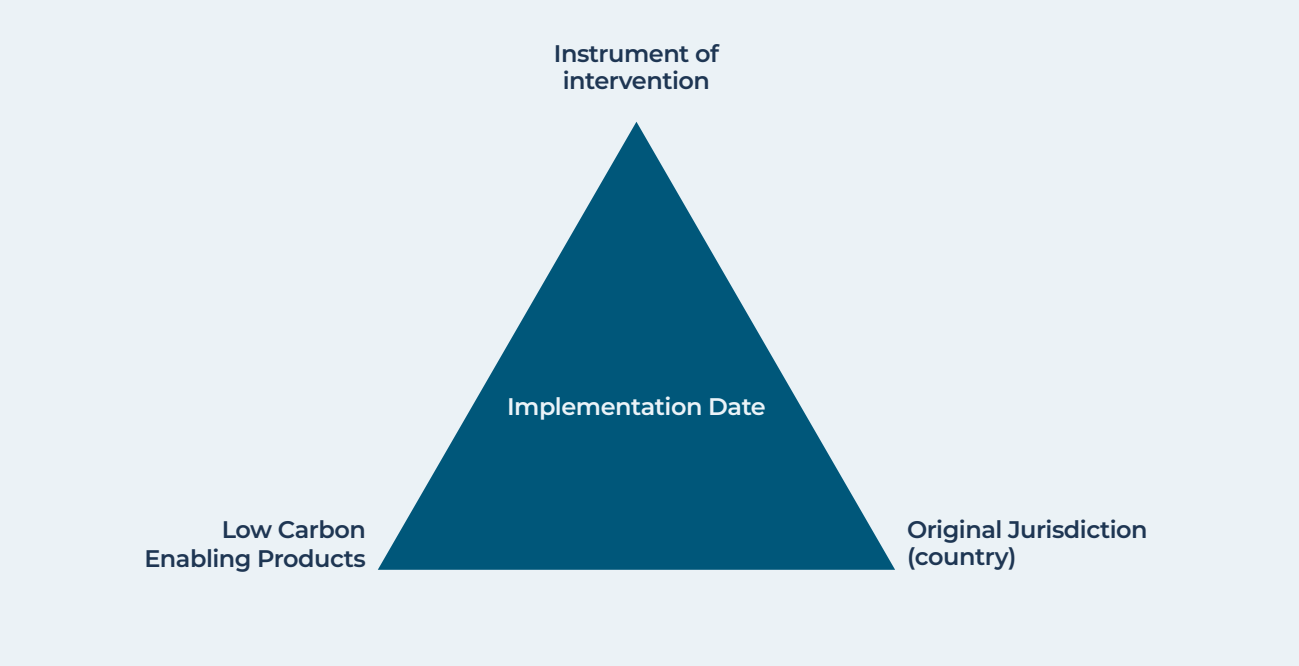
[5] The following news provides an example of such broad coverage: "in July 2024, The Canada Infrastructure Bank announced a CAD 100 million (USD 73.13 million) loan to GDI Integrated Facility Services to support deep energy retrofit projects" (Canada..., 2024).

Given the limited advance of industrial policy-related statistics, the GTA database provides valuable information about the nature and the extent of policy interventions. It provides quantitative evidence on the type of activism countries are engaged in, thus paving the ways for studies that would investigate the subsequent consequences of national States' actions.

2.2 Analytical variables

This paper adopts three variables for the comparative analysis of countries' intervention to foster or protect LCEP **(Figure 2)**. Data was extracted from the GTA database on June 13, 2024, and covers the period running from January 1, 2008, until June 13, 2024.

Figure 2 – The frame of reference: analytical variables



Source: Own elaboration.

"Instrument of intervention" is the guiding variable for the analysis as it indicates the action implemented, thus the efficacy of intervention, by a country, following the definition proposed by the GTA based on Unctad (2019). **"Original jurisdiction"** includes the countries covered by the GTA database, where the interventions emanated from. **"Low carbon enabling products"** are products that directly or indirectly contribute to the

lowering of carbon emissions along production chains **(See Box 1)**. As this article aims at investigating the nature of countries' activism, each intervention represents one unit of action by one country, in one year, regardless the number of products sheltered under that specific intervention and the number of affected jurisdictions. That is, an import tariff measure is one "intervention unit" even if such measure may include one or more products and affect one or more countries.

Box 1 - What are Low-Carbon Enabling Products?

Despite the strategic importance of low carbon products and technologies, there is no agreed-upon methodology to define them precisely. IMF (2021a, p.1) defines low carbon technology products (LCTs) as "products that produce less pollution than their traditional energy counterparts and will play a vital role in the transition to a low carbon economy. LCTs include mechanics like wind turbines, solar panels, biomass systems and carbon capture equipment". Based on this generic definition, the IMF proposes a list of low-emission technology products (for a full list of products see Annex 2). The listed products –capital goods, electric/electronic devices, or transport equipment– have the special function of inducing the reduction of carbon emissions by themselves and/or by the impact they cause in end users. IMF (2021b) provides background information about such a feature.

When considering the scope of what can be designed as a list of low carbon products, it is essential to keep in mind their indicative role, due to functional issues related to their nature and use. Some products are inherently low carbon devices, such as solar panels; others are inducive to the lowering of emissions, such as the catalytic converters for automobile exhaust systems. However, there are products that can be used for environmental remediation as well as in other unrelated industrial processes. In view of that and considering the direct or indirect function (the lowering of carbon emissions) that any given product may have when in operation, this study uses the expression "low-carbon enabling products" (LCEP) instead of following IMF's denomination of "low-carbon technology products."

Table 1 below presents an overview of the GTA's complete database and LCEP coverage. GTA registers 68 different types of instruments of intervention in the complete database and 58 for the LCEP. In terms of products, as classified by the Harmonized System -HS- **(World Customs Organization 2022)**[6], the GTA complete database registers interventions affecting a universe of 5,207 products and a universe of 119 LCEP related ones.

Table 1 – All-in and low carbon enabling products in the GTA database

	Number of original jurisdictions (countries)	Number of affected jurisdictions (countries)	Number of instruments of intervention**	Number of Harmonized System Products
Complete Original Data	197	235	68	5,207
Low Carbon Enabling Products* database	197	235	58	119

Notes: (*) See IMF (2021b) for the complete list of low carbon technology products; (**) see Evenett and Fritz (2020) for the complete list of instruments of intervention
Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

The present study focuses on a subset of instruments, countries, and products. We centered the analysis on the five most frequently implemented instruments of intervention (top five instruments) by the 10 most active countries (top 10 countries) towards the 10 most affected low carbon enabling products (top 10 LCEP). Thus, organized by instruments of intervention, and bringing to fore the most active countries per instrument, the following section presents the related empirical analysis.

[6] The Harmonized System is a standardized numerical method of classifying traded products developed and maintained by the World Customs Organization.

3. Instruments, products and countries: an overview

The five policy instruments most frequently implemented to foster or protect LCEP by all countries responded for 8,733 (72.7%) out of 12,017 total interventions towards LCEP **(see Table 2)**. These instruments are Import Tariffs, Financial Grants, Trade Finance, State Loans, and Export Bans **(see Box 2; for a full definition of each instrument see Appendix A).**

Table 2 – Number of interventions by all countries that affected LCEP, January 2008-June 2024

Instrument of intervention	Number of instruments implemented	Share of top five instruments
Import Tariffs	3,991	45,7%
Financial Grants	2,537	29,1%
Trade Finance	960	11,0%
State Loan	845	9,7%
Export Bans	400	4,6%
Total Top five instruments	8,733	100,0%
Total Interventions	**12,017**	

Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

Import Tariffs and Financial Grants concentrate about 75% of all five policy instruments. Three of these (Financial Grants, Trade Finance, State Loans) are of financial nature and are incentives for expanding local production capacity and capabilities. The fourth one is a tax-related instrument (Import Tariffs), a mechanism to constraint (when augmented) or to facilitate (when reduced) the importation of foreign products, usually used as a mechanism to induce local production, and the fifth is a regulatory measure (Export Bans), a constraint on foreign sales usually oriented to ensure adequate supply to the local market demand.

Box 2 - Definition of five policy instruments most frequently implemented to foster or protect Low Carbon Enabling Products

- Import tariffs are taxes imposed by the pertinent authority to lower or increase the costs of imports of goods into a given country. Usually, the characteristics of the imported goods determine the percentage over the value of goods that will be levied on them. In some contexts, import tariffs also means import duties, customs duties, tariffs or import tax.

- Financial Grants are one-off or recurrent non-repayable, interest-free transfers of public funds to enterprises, whether conditional or unconditional.

- Trade Finance is the public support for enterprises to engage in sales in foreign markets. Such support can come under different forms of financing such as grants, loans, equity infusions, guarantees and price support.

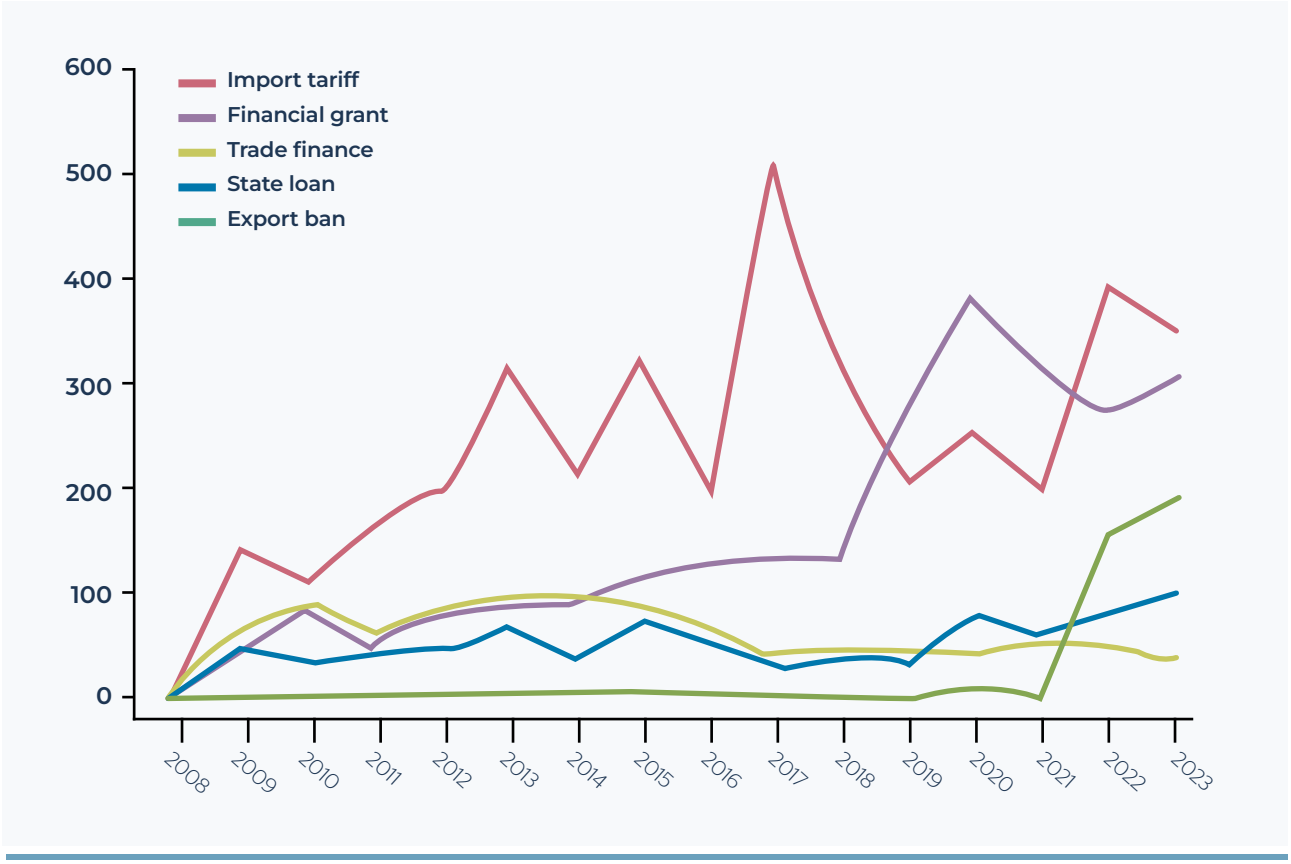
- State Loans is the direct lending to an enterprise in favorable terms.

- Export bans are measures to restrict the exports of a set of products through export quotas or straightforward prohibition to firms to engage in foreign sales. It is most probable that each of these instruments would have "national characteristics" in the way they are designed and implemented.

Source: Own elaboration based on data from the Global Trade Alert (2024b).

Considering the top 10 original jurisdictions over the 2008-2023 period, Import Tariff was the most frequently used instrument, only being surpassed by Financial Grants in the years 2019 to 2021, a period partially related to the Covid-19 pandemic **(Figure 3)**. Additionally, the use of Financial Grants gradually increased over the period, which is also true for Export Bans, but only recently, from 2021 to 2023. Both Trade Finance and State Loans maintained their participation constant over the years.

Figure 3 – Top five intervention instruments implemented by all countries, 2008-2023



Note: Given data limitation, this chart does not include the January-June 2024 period.
Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

LCEP are mostly concentrated in different types of machinery, electric/electronic devices, and **transport equipment**[7]. **Table 3** provides information from the product angle: that of the LCEP affected by instruments of interventions, by the 10 most active countries. The five most prominent instruments of intervention affected 35,241 LCEP, with a clear prevalence of Import Tariffs. However, if only the 10 most affected LCEP were considered, the relative importance of the Financial Grant instrument would increase, reaching a level like that of Import Tariffs.

Table 3 – Number of LCEP affected by the five most used instruments of intervention by the top 10 countries, January 2008-June 2024

Instrument of intervention	All affected LCEP		Ten most affected LCEP	
	Number of affected products	Share of each instrument (%)	Number of affected products	Share of each instrument (%)
Import Tariffs	19,907	56.5	3,720	38.8
Financial Grants	8,736	24.8	3,760	39.2
Trade Finance	3,277	9.3	1,118	11.7
State Loan	1,855	5.3	543	5.7
Export Bans	1,466	4.2	446	4.7
Total	35,241	100.0	9,587	100.0

Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

[7] LCEP are concentrated in three Unctad HS 2017 families of products, associated with the following classification codes: 84 (machinery); 85 (electric/electronic devices), and 87 (vehicles). See Annex 2.

Table 4 provides evidence on the relative activism of different countries towards LCEP. All of them have a strong industrial base, especially in the capital goods segment. The 10 most active countries are responsible for 55.9% of all countries' interventions to protect or to foster LCEP in their home market. China stands out with around 20% of the total actions implemented by the top 10 countries followed, at distance, by Brazil, the USA and Germany with between 5% and 7% of the total. The share of the other six countries is lower, between 2% and 3%. As show ahead, some countries are more, others less, concentrated in the use of one or more instruments of intervention.

Table 4 - Interventions towards LCEP by the 10 most active countries, January 2008-June 2024

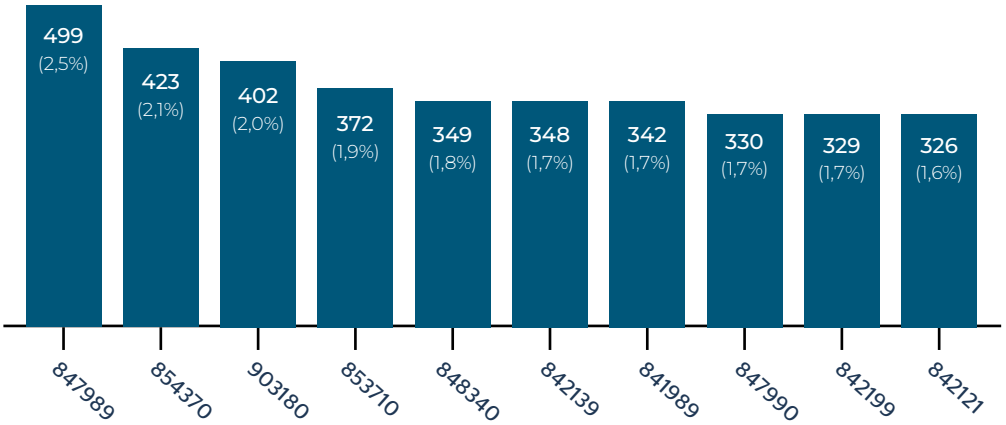
Most active countries	Number of implemented interventions towards LCEP	Share (%)
China	1,903	21.8
United States of America	642	7.4
Brazil	569	6.5
Germany	459	5.3
Australia	285	3.3
Italy	225	2.6
Canada	215	2.5
United Kingdom	209	2.4
France	200	2.3
India	173	2.0
Total Top 10 countries	**4,880**	**55.9**
Other countries	**3,853**	**44.1**
Total	**8,733**	**100.0**

Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

4. Import Tariffs: low carbon enabling products and countries

Diagram 1 lists the top 10 LCEP most affected by **Import Tariffs**[8]. These 10 LCEP accounted for only 18.7% of total import tariff actions implemented by those countries. The reason might be that import tariffs are an instrument extensively used for all kinds of products and by all countries. Intervention to protect local LCEP production is concentrated

Diagram 1 – Top 10 LCEP most affected by Import Tariffs, in number and percentage over total, January 2008-June 2024



847989	Machines and mechanical appliances; having individual functions, n.e. c. or included in this chapter
854370	Lamps; light-emitting diode (LED) lamps
903180	Other measuring or checking instruments
853710	Boards, panels, consoles, desks and other bases; for electric control or the distribution of electricity, (other than switching apparatus of heading no. 8517), for a voltage not exceeding 1000 volts
848340	Gears and gearing; (not toothed wheels, chain sprockets and other transmission elements presented separately); ball or roller screws; gear boxes and other speed changers, including torque converters
842139	Filtering or purifying machinery and apparatus for gases
841989	Other machinery, for treatment of materials by change of temperature
847990	Machines and mechanical appliances; parts, of those having individual functions
842199	Parts for filtering or purifying machinery
842121	Water filtering or purifying machinery and apparatus

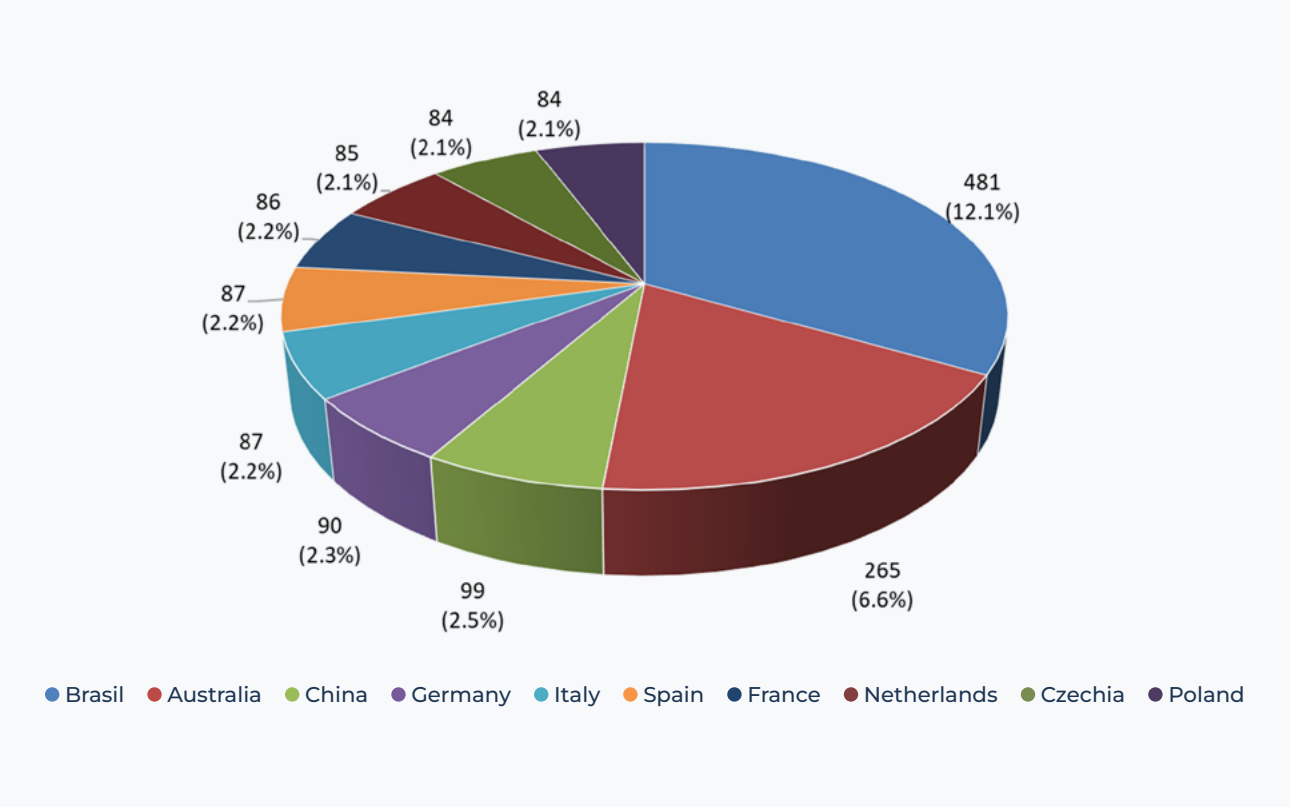
Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

[8] For an example, see the alert for changes on the import tariffs on multiple capital goods by the Brazilian government (Brazil..., 2018).

in three product classes: 84 (machinery), 85 (electric/electronic devices), and 90 (control instruments). The 84 class has a reference for general-purpose capital goods and a significant recurrence for water filtering or purifying equipment. In comparison, in the 85 class, LED and electric control boards prevail. The three product classes are capital goods that, when operational, can directly and/or indirectly contribute to decarbonization, especially water purifying equipment and energy control mechanisms.

Figure 4 presents the top 10 countries that implemented Import Tariffs between January 2008 and June 2024. They accounted for 36.3% of the 3,991 import tariffs applied to all LCEP by all countries covered by the GTA database during the period. The European Union countries stand out for their strong participation within the top 10 countries (37.9%), followed by Brazil (35.3%) and Australia (19.5%).

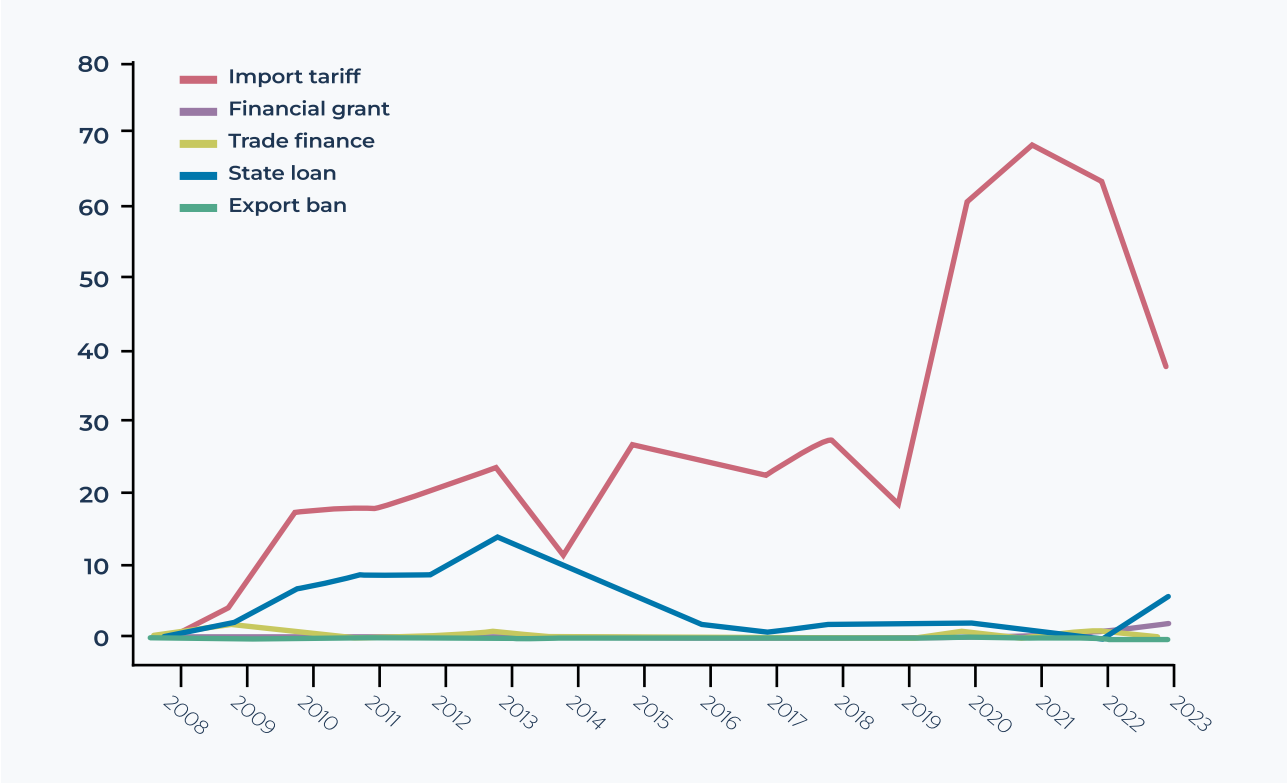
Figure 4 - Top 10 original jurisdictions that applied Import Tariffs, January 2008-June 2024



Note: Figures indicate a country´s number of interventions. Figures in brackets indicate the share of a country in the total of all countries.
Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

As a single national entity, Brazil was the most active country in the use of Import Tariffs. And, as shown in **Figure 5**, it also has placed considerable emphasis in this instrument over the time span considered. There is, however, a small participation of State Loans during 2009-2016 and the other instruments are less relevant throughout the period. This specialization in the tariff-related intervention instrument is unique to Brazil as compared to the other top countries. Although Brazil is the most frequent user of Import Tariffs, this may reflect either an increase or a decrease of tariffs. This instrument operates in the context of a special regime, the "*Ex-Tarifário*." According to the Brazilian Ministry of Development, Industry, Trade and Services, "[t]he Ex-Tariff regime consists of the temporary reduction of the import tax rate on capital goods, IT and telecommunications (BIT), as stated in the Mercosur Common External Tariff (TEC), when there is no equivalent national production" (Brasil, 2021, our translation). In particular, the peak of interventions in 2021 can be explained by a general reduction of 10% in import tariffs on 87% of **products**[9].

Figure 5 – Brazil: Top five instruments of intervention implemented, 2008-2023



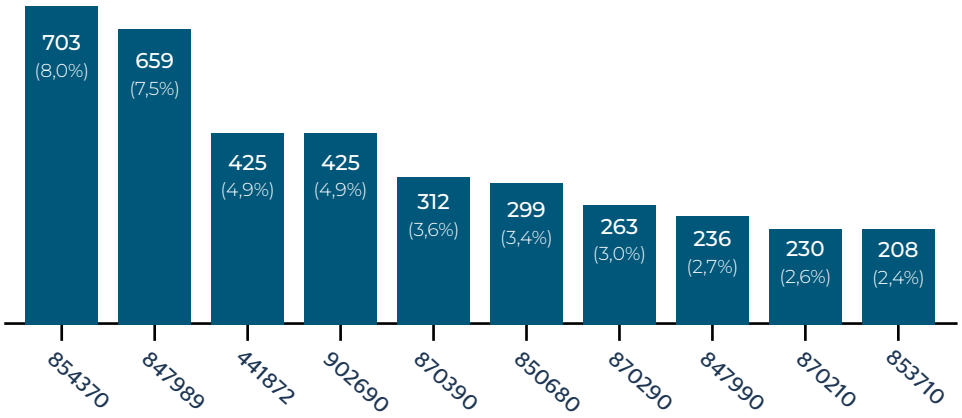
Note: Given data limitation, this chart does not cover the January-June 2024 period.
Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

[9] Bringing to the limelight the reasons behind a country's policy-intervention specialization is beyond the scope of this article and constitutes a subject for further research, which shall consider issues such as a country's history, institutional capabilities, and public-private interactions.

5. Financial Grants: low carbon enabling products and countries

Diagram 2 identifies the LCEP affected by Financial Grants from January 2008 until **June 2024**[10]. The top 10 LCEP were responsible for 43.0% of all products subjected to Financial Grants by the top 10 most active countries. The 85 class includes similar products affected

Diagram 2 – Top 10 LCEP most affected by Financial Grants, January 2008-June 2024



854370	Lamps; light-emitting diode (LED) lamps
847989	Machines and mechanical appliances; having individual functions, n.e. c. or included in this chapter
441872	Wood; assembled flooring panels, of bamboo or with at least the top layer (wear layer) of bamboo
902690	Parts of instruments for measuring, checking liquids or gases
870390	Vehicles: with both spark-ignition internal combustion reciprocating piston engine and electric motor for propulsion, incapable of being charged by plugging to external source of electric power
	Vehicles: with both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor for propulsion, incapable of being charged by plugging to external source of electric power
	Vehicles: with both spark-ignition internal combustion reciprocating piston engine and electric motor for propulsion, capable of being charged by plugging to external source of electric power
	Vehicles: with both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor for propulsion, capable of being charged by plugging to external source of electric power
	Vehicles; with only electric motor for propulsion
850680	Cells and batteries; primary, (other than manganese dioxide, mercuric oxide, silver oxide, lithium or air-zinc)
870290	Vehicles: public transport type (carries 10 or more persons, including driver), with both spark-ignition internal combustion reciprocating piston engine (diesel or semi-diesel) and electric motor for propulsion, new or used
	Vehicles: public transport type (carries 10 or more persons, including driver), with only electric motor for propulsion, new or used
847990	Machines and mechanical appliances; parts, of those having individual functions
870210	Vehicles: public transport type (carries 10 or more persons, including driver), with both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor for propulsion, new or used
853710	Boards, panels, consoles, desks and other bases; for electric control or the distribution of electricity, (other than switching apparatus of heading no. 8517), for a voltage not exceeding 1000 volts

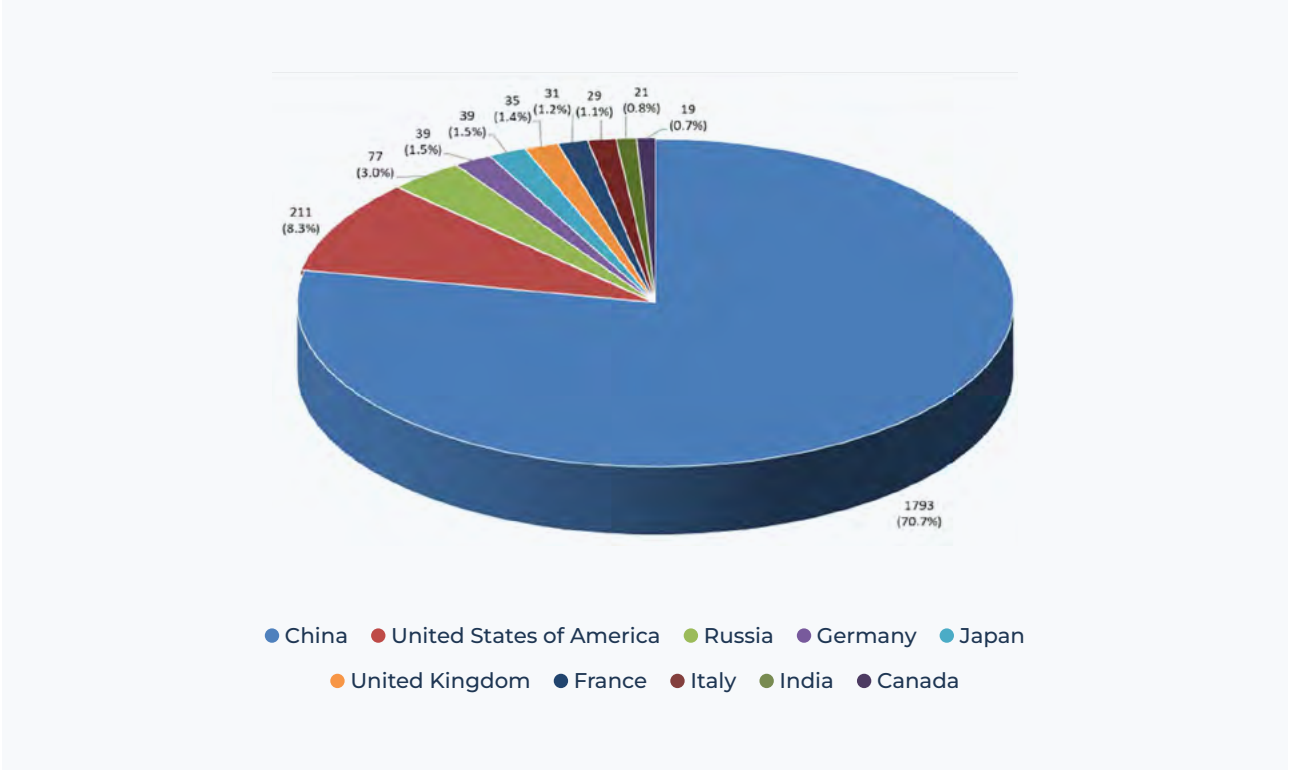
Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

[10] One example of a Financial Grant application is the Chinese government subsidy for listed company Shenzhen Silver Basis Technology Co., Ltd. (China..., 2019).

by Import Tariffs, but it also includes batteries, while the 84 class is of a generic type of capital goods (machine and mechanical appliances). The 90 class refers to control instruments. What comes out differently is the remarkable presence of the 87 class, associated with hybrid or electric vehicles.

Contrary to the use of Import Tariffs, where the top 10 countries were responsible for approximately one third of the actions of all countries, the implementation of "Financial Grants" is more concentrated. The top 10 countries accounted for 90% of all state interventions in the GTA database (2,537). Moreover, China alone accounted for 1,793 or 70.7% of all actions implemented during the January 2008-June 2024 period. Such a pattern of concentration in applying Financial Grants for LCEP differs substantially from other instruments and countries, especially when compared to the United States. Despite being the second largest user of Financial Grants, this country places much less emphasis on this instrument as indicated by its much smaller number of occurrences **(Figure 6)**.

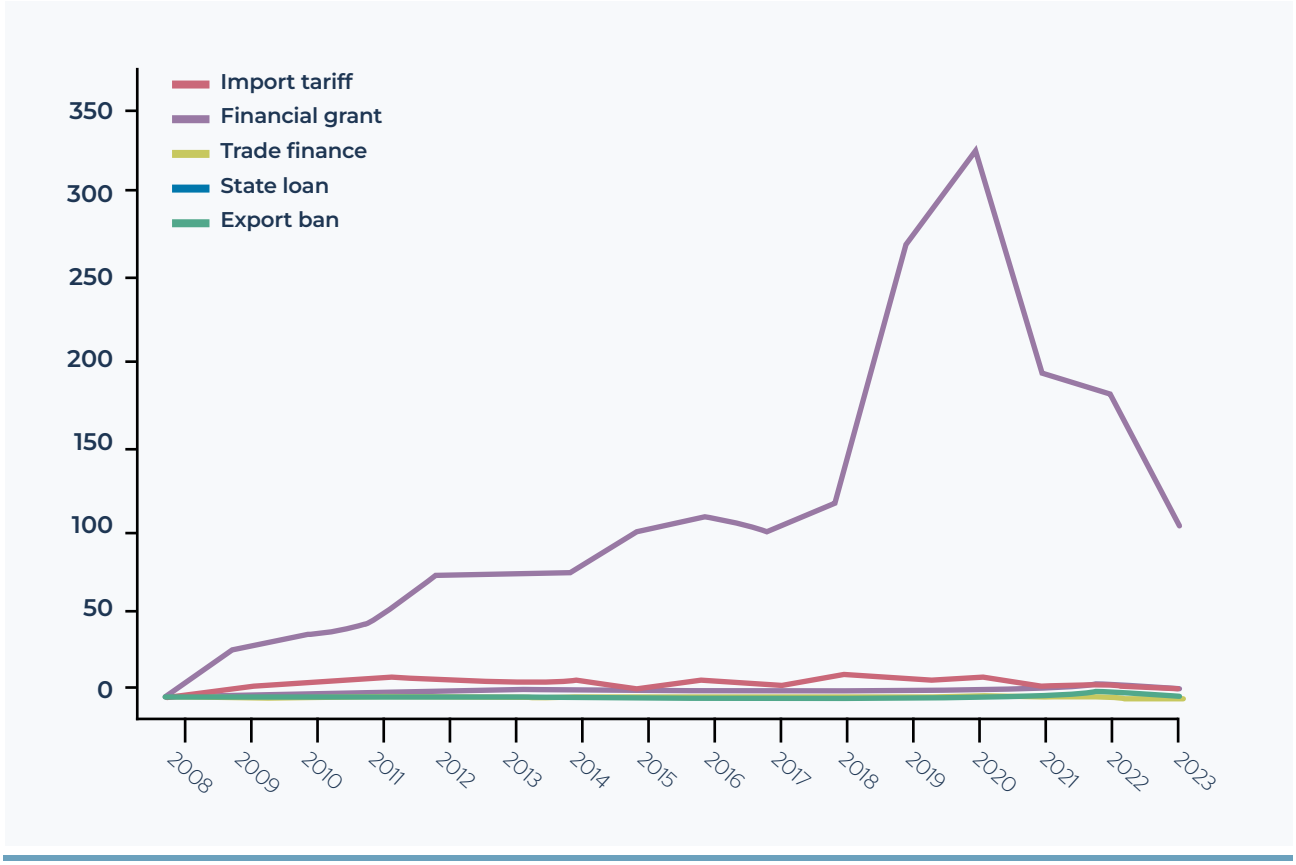
Figure 6 – Top 10 original jurisdictions that implemented Financial Grants, January 2008-June 2024



Note: Figures indicate a country's number of interventions. Figures in brackets indicate the share of a country in the total of all countries.
Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

The country-level evidence indicates another dimension of the above-mentioned concentration **(Figure 7)**. For China, Financial Grants is the intervention instrument used with the highest frequency throughout the observed period. China does not rely on other intervention instrument as much as it does on Financial Grants to support LCEP. Particularly, this instrument was heavily employed from 2019 to 2021.

Figure 7 – China: Top five instruments of intervention implemented in 2008-2023



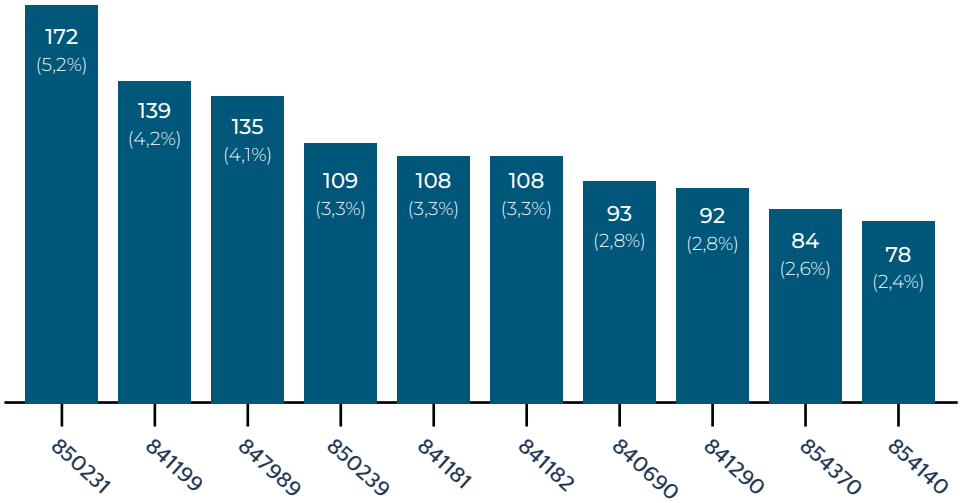
Note: Given data limitation, this chart does not cover the January-June 2024 period.
Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

It seems that the type of support China has provided along the years are bearing fruits by means of widespread foreign direct investment due to increasing dynamic competitive advantages, industrial policies in receptive countries or to circumvent trade restrictions. The electric car is the outstanding example of such trend. BYD, which disputes with Tesla for the title of largest producer of plug-ins in the world, is setting up assembly plants in Hungary, Mexico, Brazil, Indonesia, Uzbekistan and Thailand. Chery plans to set up production facilities in Spain, Mexico, Vietnam, and Argentina (Abril, 2024).

6. Trade Finance: low carbon enabling products and countries

The third most implemented instrument by countries is Trade Finance. The main products affected are related to renewable energy **(Diagram 3)**. In Trade Finance, the 85 class has been expanded to include photosensitive semiconductors and wind powered sets while the 84 class is very concentrated in gas turbines. Thus, Trade Finance is essentially used for boosting local low-carbon oriented industries and, in importing countries, the operationalization of renewable energy plants.

Diagram 3 – Top 10 LCEP most affected by Trade Finance, January 2008-June 2024

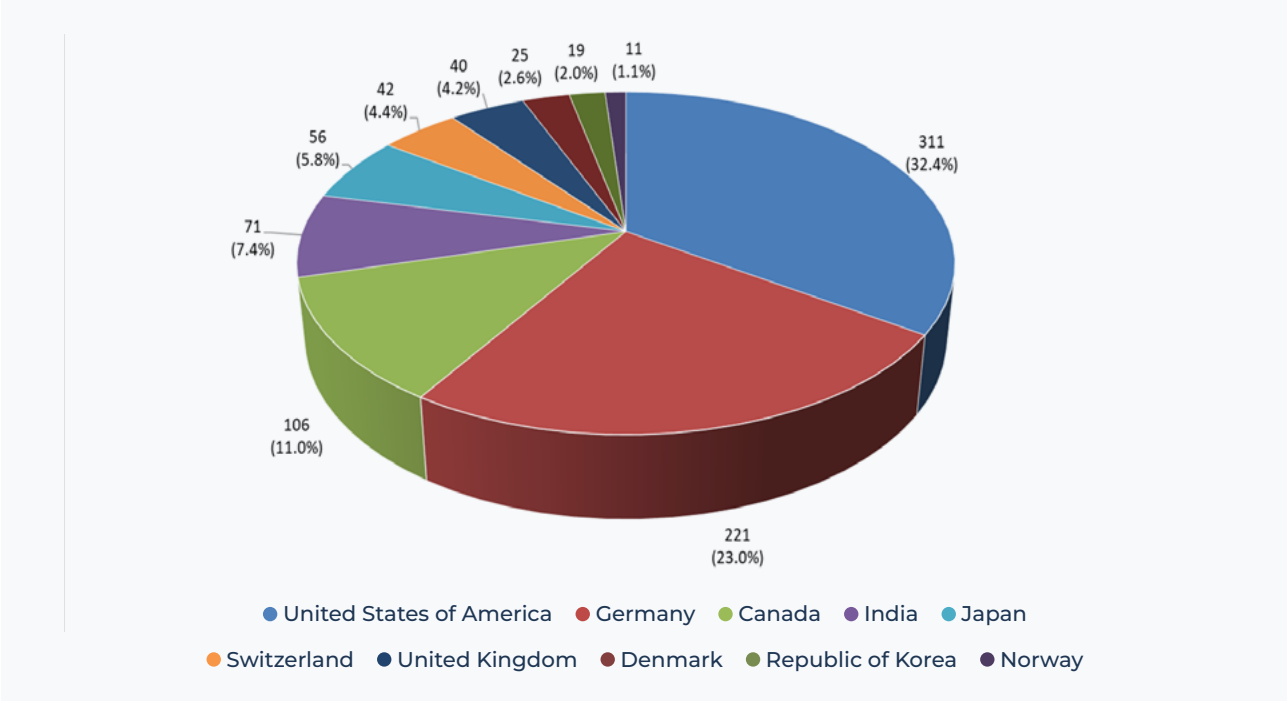


850231	Electric generating sets; wind-powered, (excluding those with spark-ignition or compression-ignition internal combustion piston engines)
841199	Turbines; parts of gas turbines (excluding turbojets and turbo-propellers)
847989	Machines and mechanical appliances; having individual functions, n.e.c. or included in this chapter
850239	Electric generating sets; (excluding those with spark-ignition or compression-ignition internal combustion piston engines), other than wind powered
841181	Turbines: gas-turbines (excluding turbo-jets and turbo-propellers), of a power not exceeding 5000kW
841182	Turbines: gas-turbines (excluding turbo-jets and turbo-propellers), of a power exceeding 5000kW
840690	Turbines; parts of steam and other vapour turbines
841290	Engines; parts, for engines and motors of heading no. 8412
854370	Lamps; light-emitting diode (LED) lamps
854140	Photosensitive semiconductor devices, including solar cells

Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

The top 10 countries are responsible for around 94% of all 960 Trade Finance actions implemented by all countries during 2008-2024. Three countries stand out as the most active users of trade finance: USA, Germany, and Canada (32.4%, 23%, and 11%, respectively), with no regional concentration. Brazil, the leading country in the use of Import Tariffs, and China, the leading country in the use of Financial Grants, are not among the group of major users of Trade Finance **(Figure 8)**. This suggests a varying national pattern of instruments of intervention in the protection or fostering of local LCEP.

Figure 8 – Top 10 original jurisdictions that implemented Trade Finance, January 2008-June 2024



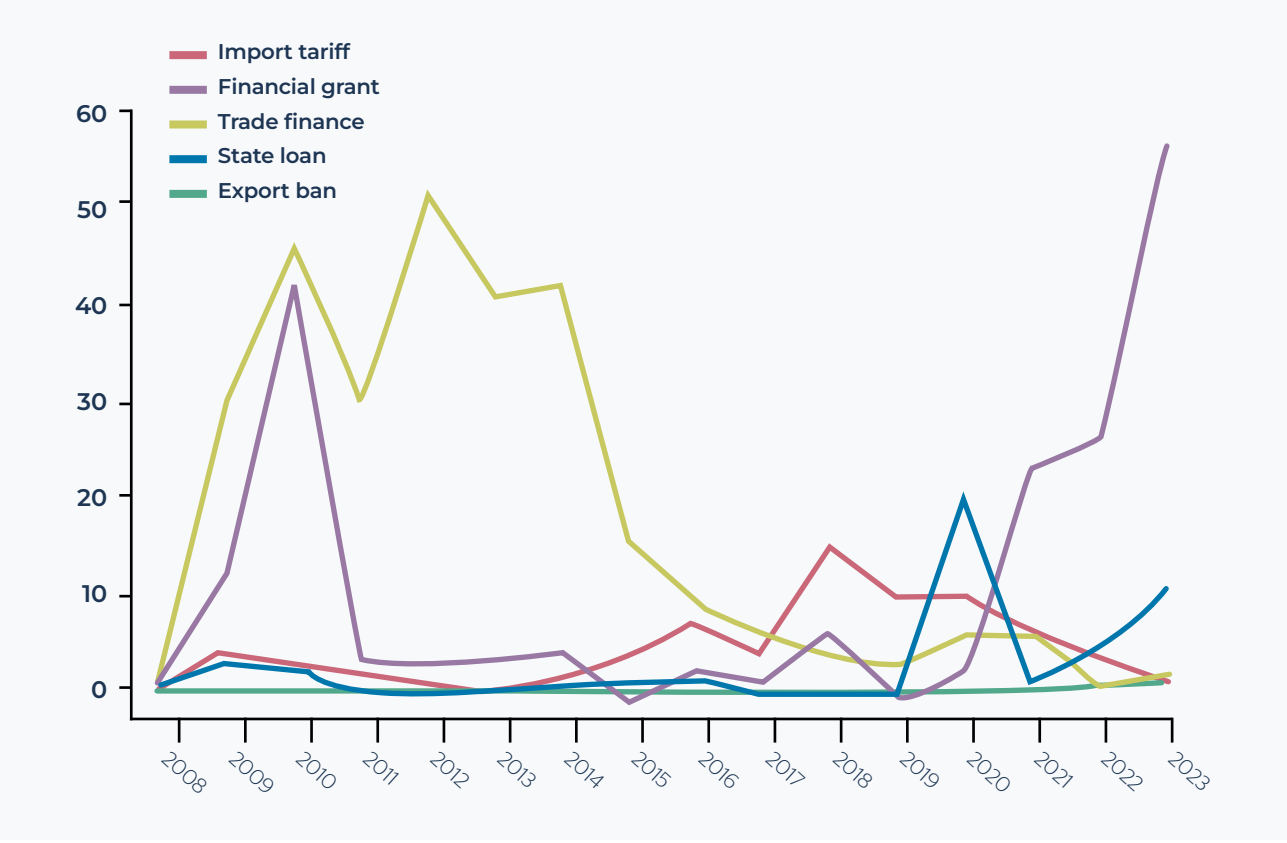
Note: Figures indicate a country's number of interventions. Figures in brackets indicate the share of a country in the total of all countries.
Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

The USA is the most active user of Trade Finance, an instrument that highly affected turbines and related products (classes 841181, 841182 and 840690). In 2022, this country was the largest world exporter (USD 32.5 billion) and importer (USD 26.2 billion) of gas turbines. The main destinations of those exports were France, Germany, the United Kingdom, Brazil, and Canada, while the fastest growing export markets between 2021 and 2022 were the United Arab Emirates, Brazil, and Qatar. In 2023, the leading companies at the forefront of shipping gas turbines were Boeing, Schaeffler Group, and GE Renewables (OEC, 2024).

Figure 9 shows that, along the years, there has been a noticeable shift in the pattern of instrument use in the USA. Trade finance was used in the aftermath of the global financial crisis and a few years thereafter, falling sharply from 2014 onwards. Financial Grants were activated in or shortly after two moments of crisis: in 2009-10 and 2020-2023 with a sharp increase in the most recent period. One example of this change in the U.S. pattern of intervention is the financial grant awarded to the Brazilian mining company Vale to finance the construction of an iron ore briquette plant. Through this agreement, Vale will receive up to $282.9 million from the U.S. Department of Energy. Vale's project involves developing an innovative iron ore briquette manufacturing facility in the United States that uses a patented cold sintering process to produce direct reduced products. According to Vale, "These briquettes can help reduce greenhouse gas emissions in steel production by up to 10% compared to traditional processes by eliminating the carbon-intensive sintering stage. This reduction is significant when you consider that the steel industry is responsible for around 8% of the world's emissions" (Brazilian..., 2024).

Import tariffs have remained low over time, with only a slight peak between 2016 and 2021. This highly touted mechanism in government and media circles in the recent past is still to emerge from the GTA statistics.

Figure 9 – USA: Top five instruments of intervention implemented in 2008-2023

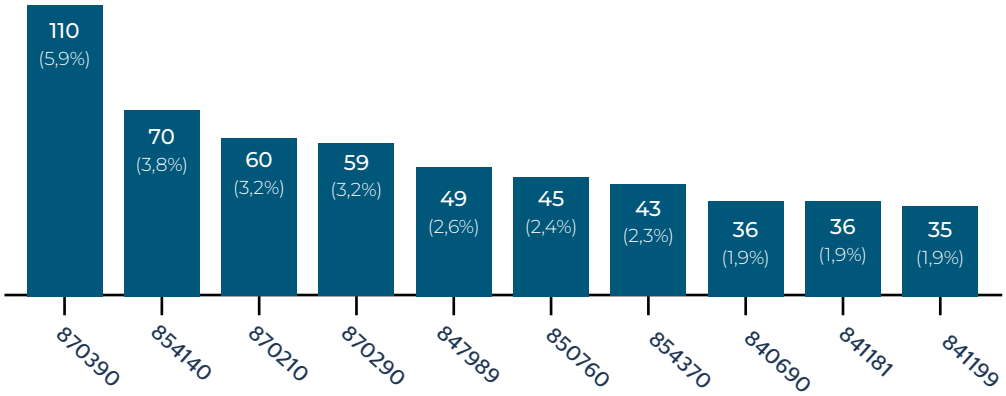


Note: Given data limitation, this chart does not cover the January-June 2024 period.
Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

7. State Loans: low carbon enabling products and countries

The products most affected by State Loan interventions are concentrated in product classes 84, 85, and 87 **(Diagram 4)**. Relatively to the three previously discussed instruments (Import Tariffs, Financial Grants, and Trade Finance), State Loans were implemented mostly to environmentally efficient devices such as gas turbines, photosensitive semiconductor devices, and hybrid and electric vehicles. This means that in different countries, public institutions were mobilized to support investment in local capacities and capabilities of firms to enter the low carbon emission trajectory.

Diagram 4 - Top 10 LCEP most affected by State Loans, January 2008-June 2024



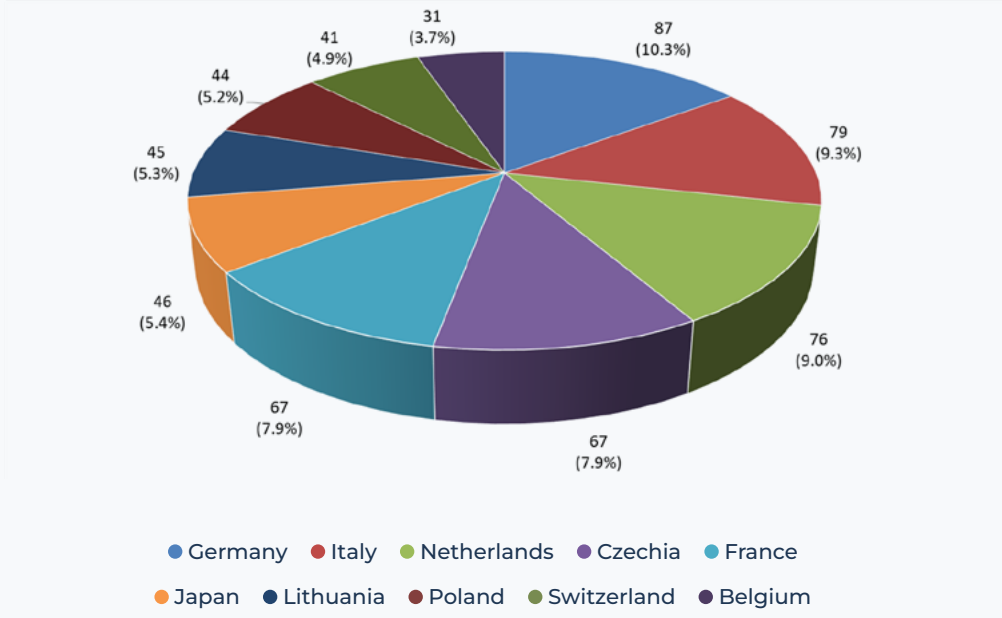
870390	Vehicles: with both spark-ignition internal combustion reciprocating piston engine and electric motor for propulsion, incapable of being charged by plugging to external source of electric power
	Vehicles: with both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor for propulsion, incapable of being charged by plugging to external source of electric power
	Vehicles: with both spark-ignition internal combustion reciprocating piston engine and electric motor for propulsion, capable of being charged by plugging to external source of electric power
	Vehicles: with both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor for propulsion, capable of being charged by plugging to external source of electric power
	Vehicles; with only electric motor for propulsion
854140	Photosensitive semiconductor devices, including solar cells
870210	Vehicles: public transport type (carries 10 or more persons, including driver), with both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor for propulsion, new or used
870290	Vehicles: public transport type (carries 10 or more persons, including driver), with both spark-ignition internal combustion reciprocating piston engine (diesel or semi-diesel) and electric motor for propulsion, new or used
	Vehicles: public transport type (carries 10 or more persons, including driver), with only electric motor for propulsion, new or used
847989	Vehicles: public transport type (carries 10 or more persons, including driver), with both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor for propulsion, new or used
850760	Electric accumulators; lithium-ion, including separators, whether or not rectangular (including square)
854370	Lamps; light-emitting diode (LED) lamps
840690	Turbines; parts of steam and other vapour turbines
841181	Turbines: gas-turbines (excluding turbo-jets and turbo-propellers), of a power not exceeding 5000kW
841199	Turbines; parts of gas turbines (excluding turbojets and turbo-propellers)

Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

The most active 10 countries were responsible for 69.0% of the 845 actions implemented by all countries, during the January 2008-June 2024 period **(Figure 10)**. When it comes to applying State Loans, the pattern of country distribution differs from the other instruments because no significant concentration of interventions in specific countries can be noted. Rather, State Loans are more equally distributed among countries. Numerically, Germany is the country with more actions concerning this instrument.

One example is that, on August 3, 2023, the KfW IPEX-Bank announced providing a loan of EUR 118 million (USD 129 million) to German heating technology provider Vaillant. The funding aims at supporting the company's development of innovative and climate-friendly heat pumps to make Vaillant a "leading heat pump provider." More specifically, the funding supports the "company's planned energy and heating system transition in the coming years." Vaillant would invest up to EUR 2 billion in the growing heat pump business, including in ongoing projects, in the following years. Vaillant operates in the fields of heating, ventilation and air-conditioning technology (Germany..., 2023).

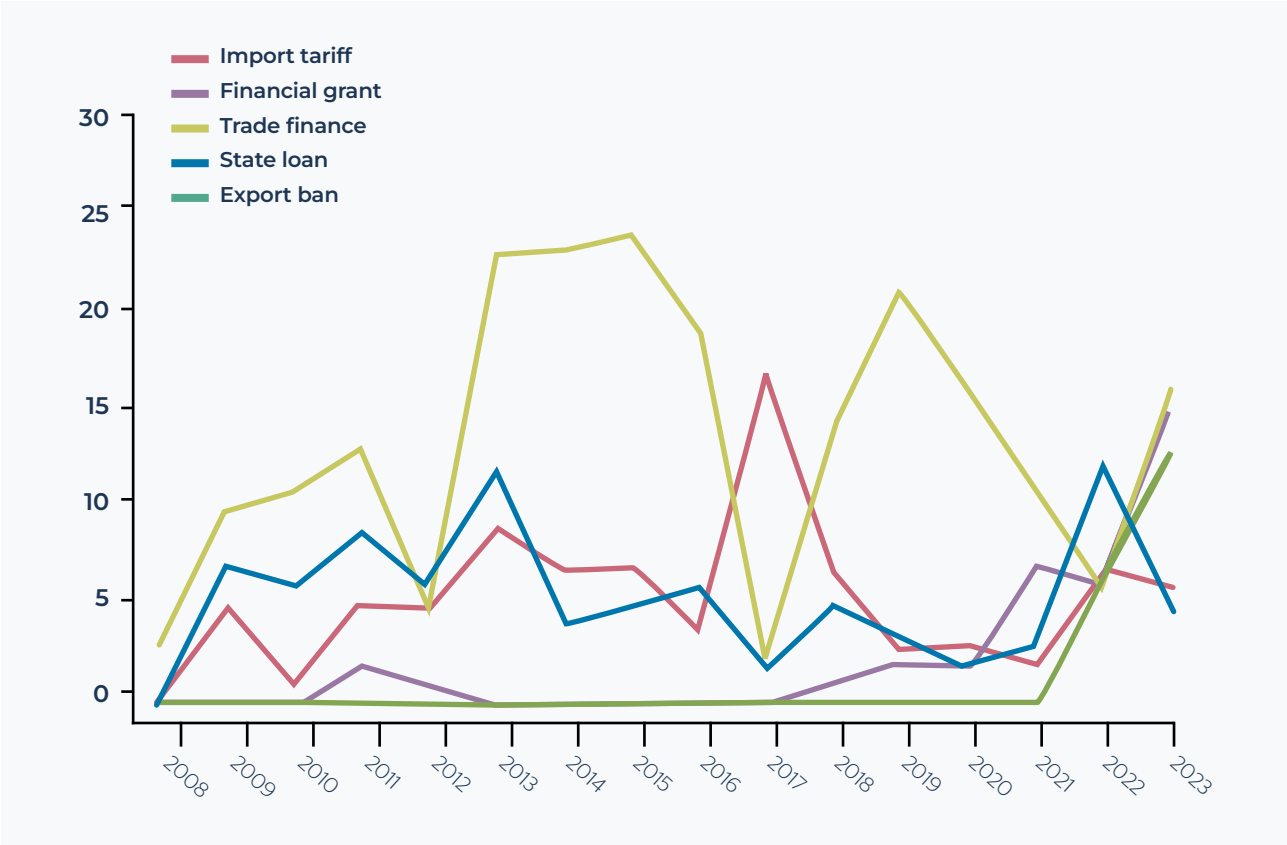
Figure 10 – Top 10 original jurisdictions that implemented State Loans, January 2008-June 2024



Note: Figures indicate a country's number of interventions. Figures in brackets indicate the share of a country in the total of all countries.
Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

Germany is also an outstanding example of a country operating a diversified portfolio of instruments of intervention to either protect or to foster its low carbon emissions industrial segments, as shown in **Figure 11**. Import tariffs have been moderately used except in one peak year (2017) while the export ban instrument was dormant until 2017 when it became a relevant instrument, with increasing intensity. Following this diversification pattern, from 2021 onwards Germany's activism can be noted by the simultaneous implementation of most available instruments for the fostering or protection of LCEP.

Figure 11 - Germany: Top five instruments of intervention implemented in 2008-2023

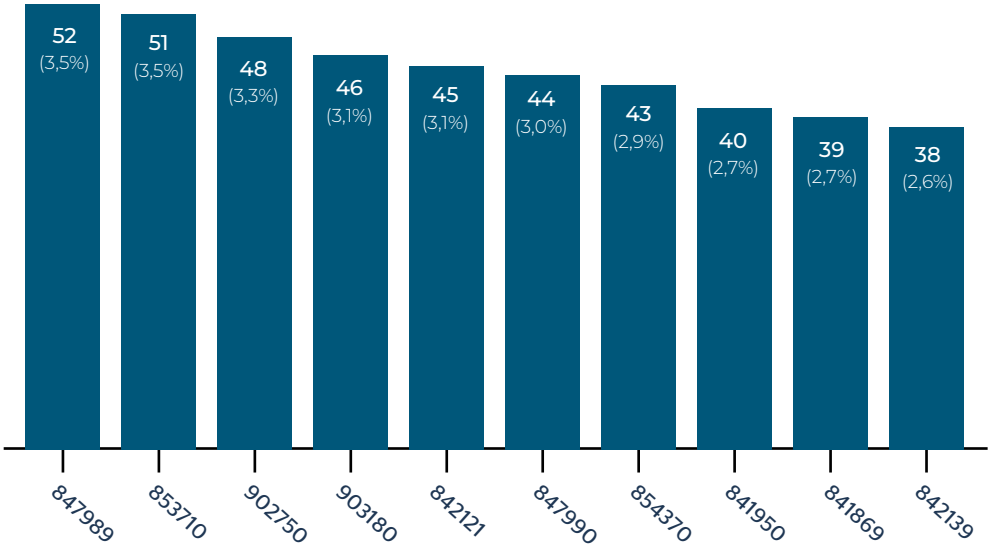


Note: Given data limitation, this chart does not cover the January-June 2024 period.
Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

8. Export Bans: low carbon enabling products and countries

Observing the characteristics of the top ten LCEP **(Diagram 5)**, the main classes remain consistent with what has been observed so far, namely, classes 84 (capital goods) and 85 (electric/electronic) with same emphasis on filtering and purifying machinery, similarly to the class of products affected by Import Tariffs. However, there is a higher participation from class 90, "Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof," which includes industrial measurement instruments and the remarkable absence of the 87 class (hybrid and electrical vehicles).

Diagram 5- Top 10 LCEP most affected by Export Bans, January 2008-June 2024

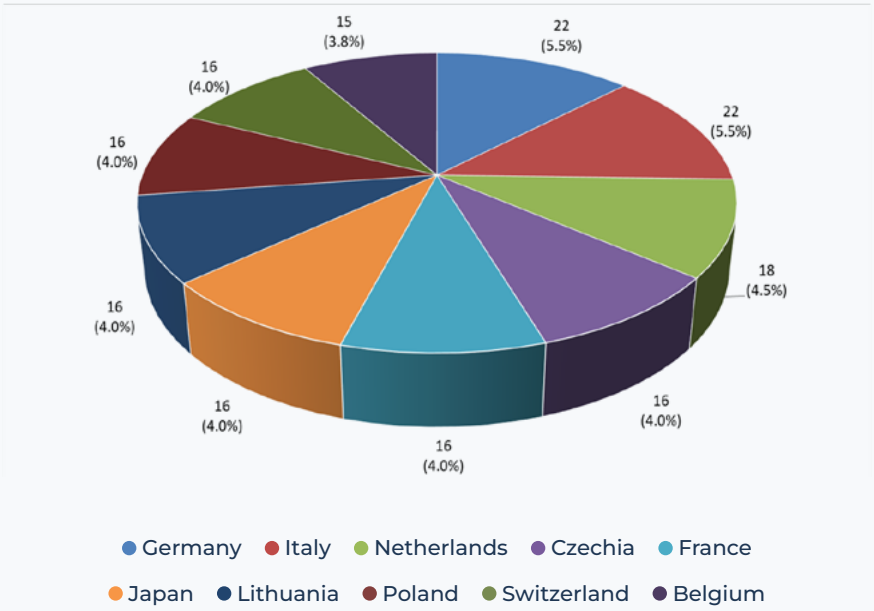


847989	Machines and mechanical appliances; having individual functions, n.e.c. or included in this chapter
853710	Boards, panels, consoles, desks and other bases; for electric control or the distribution of electricity, (other than switching apparatus of heading no. 8517), for a voltage not exceeding 1000 volts
902750	Other instruments using optical radiation
903180	Other measuring or checking instruments
842121	Water filtering or purifying machinery and apparatus
847990	Parts for heat exchange equipment
854370	Lamps; light-emitting diode (LED) lamps
841950	Heat exchange units
841869	Refrigerating or freezing equipment; n.e.c. in heading no. 8418
842139	Filtering or purifying machinery and apparatus for gases

Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

Figure 12 shows the top 10 original jurisdictions that applied Export Bans, which accounted for approximately 43% of the 400 actions implemented by all countries between January 2008 and June 2024. Similarly, to the State Loan mechanism, there is a greater dispersion among the original jurisdictions, with Italy and Germany having the largest number of interventions. Another interesting fact is that, except for Japan, all other countries in the top ten original jurisdictions are European.

Figure 12 – Top 10 original jurisdictions that applied Export Bans, January 2008-June 2024



Note: Figures indicate a country's number of interventions. Figures in brackets indicate the share of a country in the total of all countries.
Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

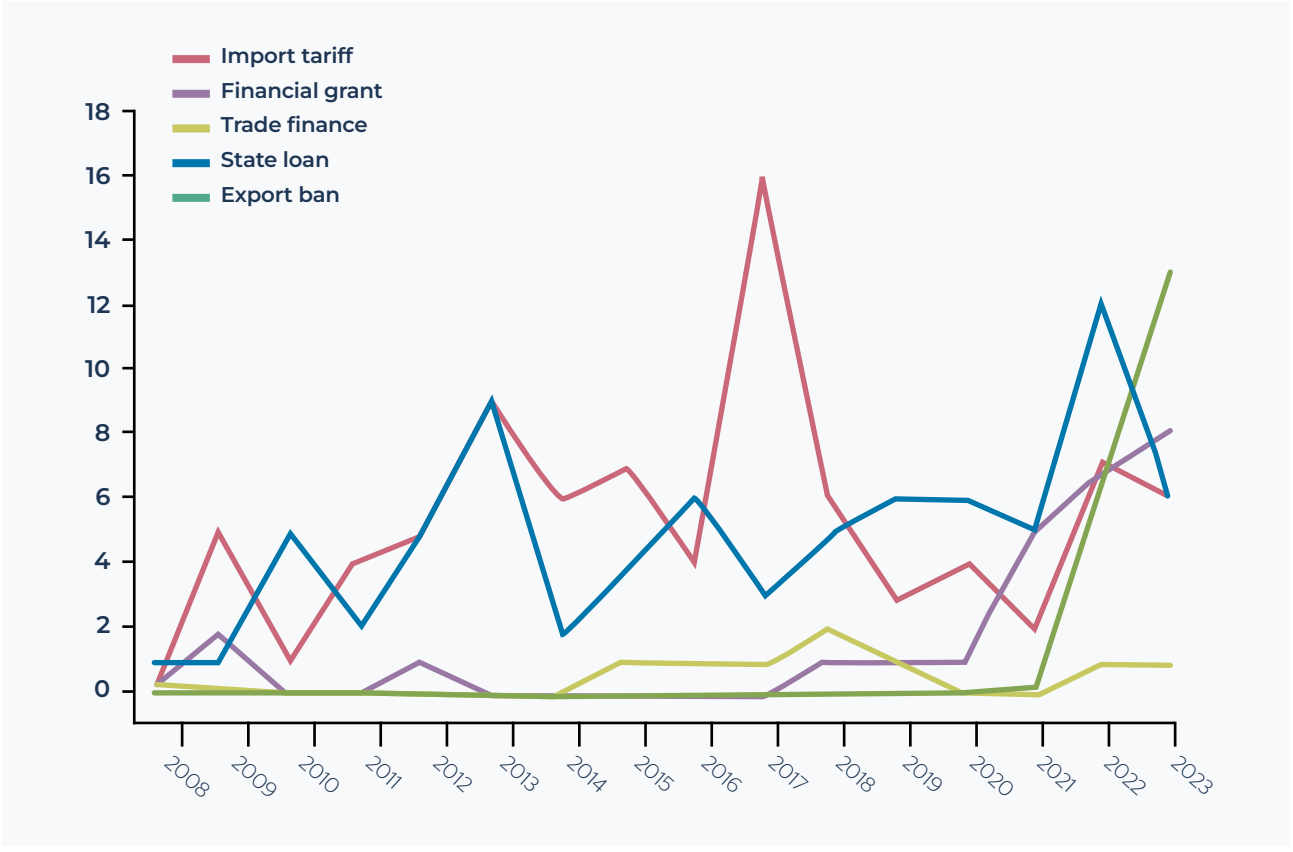
Following the same pattern of Germany, along the years Italy used all available instruments with particular emphasis on Import Tariffs and State loans while the other three (Trade Finance, Financial Grants, and Export Bans) were rarely used **(Figure 13)**.

[11] An interesting case of the use of an Export Ban for the sake of green industrial policy that explains the spike in Export Ban interventions in Italy in 2022-2023 can be found in the new EU regulations on the export of scrap. At the end of 2022, the Committee on the Environment, Public Health and Food Safety (ENVI) reviewed the European Waste Shipment Regulation (WSR). Under this new guideline of WSR, exports of non-hazardous waste — including ferrous and non-ferrous scrap metal, — will be allowed only to non-OECD countries that apply for consent and demonstrate their ability to treat waste sustainably (European Commission, 2024).

However, this trend has changed recently. Export controls **(including export bans)**[11] are increasingly implemented by Western countries to respond to two major sources of tensions, e.g., the war involving Russia and Ukraine, and the challenges of Chinese industrial competitiveness.

Italy is a good case in point. While this instrument remained unused between 2008 and 2021, in 2022-2023 it increased sharply to be the most used instrument. For example, since July 2023, firms in the aviation sector who intend to export pistons or internal combustion engines and their components – or provide brokering and technical assistance services – from Italy to Armenia, Iran, Kazakhstan and Kyrgyzstan must obtain authorization from the Ministry of Foreign Affairs. The rule aims to counter the risks of circumventing the sanctions Italy imposed (alongside EU and Western states) on Russia and Belarus. The content subject to the new measure includes rotary piston engines with spark ignition (internal combustion engines) that can be used in the aviation sector (airplanes, unmanned aerial vehicles, helicopters, autogiros, hybrid aircraft or radio-controlled models), as well as parts recognizable as intended for said engines (Why Italy..., 2023).

Figure 13 - Italy: Top five instruments of intervention implemented in 2008-2023



Note: Given data limitation, this chart does not cover the January-June 2024 period.
Source: Own elaboration based on data from the Global Trade Alert (GTA, 2024b).

Final remarks

This article presented an exploratory comparative analysis of selected intervention instruments used by selected countries to foster or protect LCEP from January 2008 to June 2024 based on data extracted from the Global Trade Alert database. It provided quantitative evidence about the national efficacy of the 10 most active countries in implementing five types of actions: Financial Grants, Trade Finance, State Loans, Import Tariffs, and Export Bans. Given the emergence of industrial policies everywhere but, at the same time, the scarce evidence-based debate about countries' practices, our analysis provides preliminary and useful information about the efficacy and the extent of countries' activism.

Of the five instruments, Import Tariffs and Financial Grants represented three quarters of the actions implemented in the period. One is an instrument to constraint the entry of foreign goods into an economy while Financial Grants is, together with Trade Finance and State Loans, an incentive mechanism to induce local capacities and capabilities in industrial segments associated with LCEP.

LCEP preponderantly fall into three families of goods: machinery, electric/electronic devices, and vehicles. Import Tariffs and Export Bans were preferably aimed at electric/electronic devices and water purifying machinery. Financial Grants were also used to support machinery and electric/electronic devices, but the main target was hybrid or electric vehicles. Concerning the products targeted by Trade Finance and State Loans, photosensitive semiconductors and wind powered sets, as well as the support for gas turbines, come to the forefront.

Policy-wise, this study provides evidence that countries differ concerning the preferred instruments of intervention to foster or protect the local production of LCEP. Country differences can be noted in at least four aspects:

- **Countries follow different specialization patterns in the use of specific instruments. Germany and Italy are more diversified than Brazil, China, and the USA, and, among these, each relies on different sets of instruments.**

- **Countries also differ in terms of their share in the total use of each instrument. Import tariffs are mostly used by Brazil, Australia, and European countries; Trade Finance, by the USA, Germany, and Australia; State Loans and Export ban are quite dispersed, and Financial Grants is where China largely prevails.**

- **Taking the top five instruments as a proxy of State activism, the 10 most active countries were responsible for 8,733 (56%) of those instruments implemented worldwide towards LCEP. China is, by far, the most proactive country with a pronounced instrument specialization (Financial Grants). The USA, Brazil, and Germany follow, but with different patterns of instrument specialization.**

- **Finally, changes can be noted over time. Brazil has always placed emphasis in Import Tariffs, but since 2021 such emphasis has receded. China shows a similar pattern: great emphasis in Financial Grants, but with a slowdown in recent years. The USA showed preference for Trade Finance in the early years, but such instrument has ceded place to Financial Grants. Although the two European countries have used all instruments with similar emphasis along the years, since 2021 their activism has increased.**

Four considerations can be drawn from the evidence that may demand further research.

In the first place, the widespread contemporaneous use of policy instruments that are considered highly distortionary by mainstream economics is remarkable. This is the case not only of tariffs and export bans, but also of State loans directed to specific firms – i.e., "picking-winners". Many of the most interventionist countries towards LCEP, historically, have been very vocal in their commitment with an open, free trade world economy.

Secondly, the roster of LCEP is a roster of manufacturing products. Efforts to support them via different policy instruments are, in fact, industrial policy in the strict sense of the term: policy to foster manufacturing sectors or manufacturing production chains. Despite the relevance of non-manufacturing economic activities in employment, income creation and environment protection, the efforts to advance towards a low-carbon economy seem to depend largely on manufacturing.

Thirdly, the technological core of a future net-zero economy lies on a rather limited set of industrial goods, related to which, once again, just a few large countries have developed the required production and technological capabilities, resources, and policy implementation know-how to compete in the global market.

Finally, one needs to discuss how preferred instruments and implementation capabilities can relate to one another. Establishing an efficient and transparent trade protection system through tariffs and export bans requires sound implementation capabilities. However, the requirements for operating a financial system capable of efficiently

directing credit and subsidies via financial grants, trade finance, and State loans may demand more robust capabilities. The first two instruments arise from normative decisions, which, to function, require a well-organized bureaucracy, a functioning system of administrative records, and interaction with private sectors. The three financial instruments require a financial organization (e.g., a development bank) with accumulated experience in the use of updated and regulated instruments, supplied with the appropriate resources and collegiate decisions. In addition, the efficient use of such instruments requires ex-ante and ex-post assessment mechanisms to verify adequacy, relevance, additionality, and temporality, all within a framework of embedded autonomy to avoid capture by public or private stakeholders (Evans, 1995). In this sense, would countries with limited institutional capacities tend to rely only on normative actions but without the necessary complementary finance support to increase local firms' production and innovation capabilities? So, one must investigate the extent to which "competition" among countries based on industrial policy measures may represent a handicap for developing economies with limited State capabilities.

Annex 1 – Specification of GTA Types of Intervention with reference to the Unctad denomination

Unctad chapter	Description	GTA intervention type
A	A Sanitary and phytosanitary measure	Sanitary and phytosanitary measure
B	B Technical barriers to trade	Technical barrier to trade
CAP	Capital control measures	Repatriation & surrender requirements
CAP	Capital control measures	Controls on commercial transactions and investment instruments
CAP	Capital control measures	Controls on credit operations
CAP	Capital control measures	Control on personal transactions
D	D Contingent trade-protective measures	Import monitoring
D1	D1 Antidumping	Anti-dumping
D1	D1 Antidumping	Anti-circumvention
D2	D2 Countervailing measure	Anti-subsidy
D31	D31 General (multilateral) safeguard	Safeguard
D32	D32 Agricultural special safeguard	Special safeguard
E1	E1 Non-automatic import-licensing procedures other than authorizations for SPS or TBT reasons	Import licensing requirement
E2	E2 Quotas	Import quota
E3	E3 Prohibitions other than for SPS and TBT reasons	Import ban
E6	E6 Tariff-rate quotas (TRQ)	Import tariff quota
P12	Export quotas	Foreign customer limit
F7	F7 Internal taxes and charges levied on imports	Internal taxation of imports
FDI	FDI measures	FDI: Entry and ownership rule
FDI	FDI measures	FDI: Treatment and operations, n.e.s.
FDI	FDI measures	FDI: Financial incentive
G	G Finance measures	Competitive devaluation
G	G Finance measures	Trade payment measure
I1	I1 Local content measures	Local sourcing
I1	I1 Local content measures	Local operations
I1	I1 Local content measures	Local labour
I1	I1 Local content measures	Localisation incentive
I2	I2 Trade-balancing measures	Trade balancing measure
X	Instrument unclear	Import-related non-tariff measure, n.e.s.
X	Instrument unclear	Instrument unclear
L	L Subsidies (excluding export subsidies under P7)	Bailout (capital injection or equity participation)
L	L Subsidies (excluding export subsidies under P7)	State loan

Note: n.e.s.: not elsewhere specified
Source: Evenett and Fritz (2020, p. 14-15)

Annex 1 – Specification of GTA Types of Intervention with reference to the Unctad denomination

Unctad chapter	Description	GTA intervention type
L	L Subsidies (excluding export subsidies under P7)	Financial grant
L	L Subsidies (excluding export subsidies under P7)	In-kind grant
L	L Subsidies (excluding export subsidies under P7)	Production subsidy
L	L Subsidies (excluding export subsidies under P7)	Interest payment subsidy
L	L Subsidies (excluding export subsidies under P7)	Loan guarantee
L	L Subsidies (excluding export subsidies under P7)	Tax or social insurance relief
L	L Subsidies (excluding export subsidies under P7)	Consumption subsidy
L	L Subsidies (excluding export subsidies under P7)	Import incentive
L	L Subsidies (excluding export subsidies under P7)	Financial assistance in foreign market
L	L Subsidies (excluding export subsidies under P7)	State aid
L	L Subsidies (excluding export subsidies under P7)	Price stabilisation
M1	M1 Government Procurement Market Access Restrictions	Public procurement access
M2	M2 Government Procurement Domestic Price Preference	Public procurement preference margin
M3	M3 Government Procurement Local Content Requirement	Public procurement localisation
M5	M5 Government Procurement Tendering Process	Public procurement, n.e.s
MIG	Migration measures	Labour market access
MIG	Migration measures	Post-migration treatment
N	N Intellectual Property	Intellectual property protection
P11	P11 Export prohibition	Export ban
P12	P12 Export quotas	Export tariff quota
P12	P12 Export quotas	Export quota
P13	P13 Licensing- or permit requirements to export	Export licensing requirement
P5	P5 Export taxes and charges	Export tax
P7	P7 Export subsidies	Tax-based export incentive
P7	P7 Export subsidies	Export subsidy
P7	P7 Export subsidies	Trade finance
P8	P8 Export credits	Other export incentive
P9	P9 Export measures, n.e.s.	Export-related non-tariff measure,
Tariff	Tariff measures	Import tariff

Note: n.e.s.: not elsewhere specified
Source: Evenett and Fritz (2020, p. 14-15)

Annex 2 – IMF's Low Carbon Technology Product Table

HS2017	Description	HS2012
252390	Cement; hydraulic kinds n.e.c. in heading no. 2523	252390
280519	Alkali or alkali-earth metals; other than sodium and calcium	280519
282520	Lithium oxide and hydroxide	282520
282690	Fluorides; fluorosilicates, fluoroaluminates and other complex fluorine salts, n.e.s. in heading no. 2826	282690
282739	Chlorides; other than of ammonium, calcium, magnesium, aluminium, iron, cobalt, nickel and zinc	282739
283691	Carbonates; lithium carbonate	283691
392010	Plastics; plates, sheets, film, foil and strip (not self-adhesive), of polymers of ethylene, non-cellular and not reinforced, laminated, supported or similarly combined with other materials	392010
441873	Wood; assembled flooring panels, of bamboo or with at least the top layer (wear layer) of bamboo	441872
560314	Nonwovens; whether or not impregnated, coated, covered or laminated, of man-made filaments, (weighing more than 150g/m2)	560314
680610	Slag wool, rock wool and similar mineral wools (including intermixtures thereof), in bulk, sheets or rolls	680610
680690	Minerals; mixtures and articles of heat-insulating, sound-insulating or sound-absorbing mineral materials, other than those of heading no. 6811 or 6812 or of chapter 69	680690
700800	Multiple walled insulating units of glass	700800
701931	Glass fibres; non-woven products, mats	701931
701939	Glass fibres; webs, mattresses, boards and similar non-woven products excluding mats and thin sheets	701939
730820	Iron or steel; structures and parts thereof, towers and lattice masts	730820
730900	Reservoirs, tanks, vats and similar containers; for any material (excluding compressed or liquefied gas), of iron or steel, capacity exceeding 300l, whether or not lined or heat insulated	730900
732111	Cooking appliances and plate warmers; for gas fuel or for both gas and other fuels, of iron or steel	732111
732190	Domestic appliances; non-electric, parts thereof, of iron or steel	732190
732490	Iron or steel; sanitary ware and parts thereof, excluding sinks, wash basins and baths	732490
761100	Aluminium; reservoirs, tanks, vats and similar containers, for material (not compressed or liquefied gas), of a capacity over 300l, whether or not lined, not fitted with mechanical/thermal equipment	761100
761290	Aluminium; casks, drums, cans, boxes and the like for any material (not compressed or liquefied gas), 300l capacity or less, whether or not lined or heat-insulated, no mechanical or thermal equipment	761290
840110	Nuclear reactors	840110
840120	Machinery and apparatus; for isotopic separation, and parts thereof	840120

Note: n.e.c.: not elsewhere classified.

Source: Adapted from IMF Statistics (2021a), Table HS_LCT.

Annex 2 – IMF's Low Carbon Technology Product Table

HS2017	Description	HS2012
840140	Nuclear reactors; parts thereof	840140
840219	Boilers; vapour generating boilers, including hybrid boilers n.e.c. in heading no. 8402	840219
840290	Boilers; parts of steam or other vapour generating boilers	840290
840410	Boilers; auxiliary plant, for use with boilers of heading no. 8402 or 8403 (e.g. economisers, super-heaters, soot removers, gas recoverers)	840410
840420	Boilers; parts of steam or other vapour generating boilers	840420
840490	Boilers; parts of auxiliary plant, for use with boilers of heading no. 8402 and 8403 and parts of condensers for steam or other vapour power units	840490
840510	Generators; producer gas, water gas, acetylene gas and similar water process gas generators, with or without their purifiers	840510
840681	Turbines; steam and other vapour turbines, (for other than marine propulsion), of an output exceeding 40MW	840681
840690	Turbines; parts of steam and other vapour turbines	840690
841011	Turbines: hydraulic turbines and water wheels, of a power not exceeding 1000kW	841011
841012	Turbines: hydraulic turbines and water wheels, of a power exceeding 1000kW but not exceeding 10000kW	841012
841013	Turbines; hydraulic turbines and water wheels, of a power exceeding 10000kW	841013
841090	Parts for hydraulic turbines	841090
841181	Turbines: gas-turbines (excluding turbo-jets and turbo-propellers), of a power not exceeding 5000kW	841181
841182	Turbines; gas-turbines (excluding turbojets and turbo-propellers), of a power exceeding 5000kW	841182
841199	Turbines; parts of gas turbines (excluding turbojets and turbo-propellers)	841199
841290	Engines; parts, for engines and motors of heading no. 8412motors of heading no. 8412	841290
841581	Air conditioning machines; containing a motor driven fan, other than window or wall types, incorporating a refrigerating unit and a valve for reversal of the cooling/heat cycle (reversible heat pumps)	841581
841780	Other furnaces, ovens, incinerators, non-electric	841780
841790	Parts of furnaces, non-electric	841790
841861	Heat pumps; other than air conditioning machines of heading no. 8415	841861
841869	Refrigerating or freezing equipment; n.e.c. in heading no. 8418	841869
841919	Other instantaneous or storage water heaters, non-electric	841919
841939	Dryers; for products n.e.c. in heading no. 8419, not used for domestic purposes	841939
841940	Distilling or rectifying plant; not used for domestic purposes	841940
841950	Heat exchange units	841950

Note: n.e.c.: not elsewhere classified.
Source: Adapted from IMF Statistics (2021a), Table HS_LCT.

Annex 2 – IMF's Low Carbon Technology Product Table

HS2017	Description	HS2012
841960	Machinery for liquefying air or other gases	841960
841989	Other machinery. for treatment of materials by change of temperature	841989
841990	Parts for heat exchange equipment	841990
842121	Water filtering or purifying machinery and apparatus	842121
842129	Other machinery for purifying liquids	842129
842139	Filtering or purifying machinery and apparatus for gases	842139
842199	Parts for filtering or purifying machinery	842199
847420	Machines; for crushing or grinding earth, stone, ores or other mineral substances	847420
847982	Other machines for mixing/grinding, etc.	847982
847989	Machines and mechanical appliances; having individual functions, n.e.c. or included in this chapter	847989
847990	Machines and mechanical appliances; parts, of those having individual functions	847990
848340	Gears and gearing; (not toothed wheels, chain sprockets and other transmission elements presented separately); ball or roller screws; gear boxes and other speed changers, including torque converters	848340
848360	Clutches and shaft couplings (including universal joints)	848360
850161	Generators; AC generators, (alternators), of an output not exceeding 75kVA	850161
850162	Electric generators; AC generators, (alternators), of an output exceeding 75kVA but not exceeding 375kVA	850162
850163	Electric generators; AC generators, (alternators), of an output exceeding 375kVA but not exceeding 750kVA	850163
850164	Electric generators; AC generators, (alternators), of an output exceeding 750kVA	850164
850231	Electric generating sets; wind-powered, (excluding those with spark-ignition or compression-ignition internal combustion piston engines)	850231
850239	Electric generating sets; (excluding those with spark-ignition or compression-ignition internal combustion piston engines), other than wind powered	850239
850300	Electric motors and generators; parts suitable for use solely or principally with the machines of heading no. 8501 or 8502	850300
850490	Electrical transformers, static converters and inductors; parts thereof	850490
850650	Cells and batteries; primary, lithium	850650
850680	Cells and batteries; primary, (other than manganese dioxide, mercuric oxide, silver oxide, lithium or air-zinc)	850680

Note: n.e.c.: not elsewhere classified.
Source: Adapted from IMF Statistics (2021a), Table HS_LCT.

Annex 2 – IMF's Low Carbon Technology Product Table

HS2017	Description	HS2012
850710	Electric accumulators: lead-acid, of a kind used for starting piston engines, including separators, whether or not rectangular (including square)	850710
850720	Electric accumulators; lead-acid, (other than for starting piston engines), including separators, whether or not rectangular (including square)	850720
850730	Electric accumulators; nickel-cadmium, including separators, whether or not rectangular (including square)	850730
850740	Electric accumulators; nickel-iron, including separators, whether or not rectangular (including square)	850740
850750	Electric accumulators; nickel-metal hydride, including separators, whether or not rectangular (including square)	850750
850760	Electric accumulators; lithium-ion, including separators, whether or not rectangular (including square)	850760
850780	Electric accumulators; other than lead-acid, nickel-cadmium, nickel-iron, nickel-metal hydride and lithium-ion, including separators, whether or not rectangular (including square)	850780
850790	Electric accumulators; parts n.e.c. in heading no. 8507	850790
851410	Industrial or laboratory electric resistance furnaces	851410
851420	Industrial or laboratory induction or dielectric furnaces	851420
851430	Other industrial or laboratory electric furnaces and ovens	851430
851490	Parts, industrial or laboratory electric furnaces	851490
853120	Signaling apparatus; electric, sound or visual, indicator panels incorporating liquid crystal devices (LCD) or light-emitting diodes (LED), excluding those of heading no. 8512 or 8530	853120
853224	Electrical capacitors; fixed, ceramic dielectric, multilayer	853224
853710	Boards, panels, consoles, desks and other bases; for electric control or the distribution of electricity, (other than switching apparatus of heading no. 8517), for a voltage not exceeding 1000 volts	853710
853931	Fluorescent lamps, hot cathode	853931
853950	Lamps; light-emitting diode (LED) lamps	854370
854140	Photosensitive semiconductor devices, including solar cells	854140
854390	Electrical machines and apparatus; parts of the electrical goods of heading no. 8543	854390
860120	Rail locomotives; powered by electric accumulators	860120
870220	Vehicles: public transport type (carries 10 or more persons, including driver), with both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor for propulsion, new or used	870210
870230	Vehicles: public transport type (carries 10 or more persons, including driver), with both spark-ignition internal combustion reciprocating piston engine (diesel or semi-diesel) and electric motor for propulsion, new or used	870290

Note: n.e.c.: not elsewhere classified.
Source: Adapted from IMF Statistics (2021a), Table HS_LCT.

Annex 2 – IMF's Low Carbon Technology Product Table

HS2017	Description	HS2012
870240	Vehicles: public transport type (carries 10 or more persons, including driver), with only electric motor for propulsion, new or used	870290
870340	Vehicles: with both spark-ignition internal combustion reciprocating piston engine and electric motor for propulsion, incapable of being charged by plugging to external source of electric power	870390
870350	Vehicles: with both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor for propulsion, incapable of being charged by plugging to external source of electric power	870390
870360	Vehicles: with both spark-ignition internal combustion reciprocating piston engine and electric motor for propulsion, capable of being charged by plugging to external source of electric power	870390
870370	Vehicles: with both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor for propulsion, capable of being charged by plugging to external source of electric power	870390
870380	Vehicles; with only electric motor for propulsion	870390
871160	Motorcycles (including mopeds) and cycles; fitted with auxiliary motor, with electric motor for propulsion, with or without sidecars; sidecars	871190
900190	Optical elements: lenses n.e.c. in heading no. 9001, prisms, mirrors and other optical elements, unmounted, of any material (excluding elements of glass not optically worked)	900190
900290	Optical elements: n.e.c. in heading no. 9002 (e.g. prisms and mirrors), mounted, being parts or fittings for instruments or apparatus, of any material (excluding elements of glass not optically worked)	900290
901380	Optical devices, appliances and instruments; n.e.c. in heading no. 9013 (including liquid crystal devices)	901380
901390	Optical appliances and instruments; parts and accessories for articles of heading no. 9013	901390
901580	Surveying equipment; articles n.e.c. in heading no. 9015, including hydrographic, oceanographic, hydrological, meteorological or geophysical instruments and appliances (excluding compasses)	901580
902610	Instruments for measuring the flow or level of liquids	902610
902620	Instruments for measuring or checking pressure	902620
902680	Other instruments for measuring liquids or gases	902680
902690	Parts of instruments for measuring, checking liquids or gases	902690
902710	Instruments for analysing gas or smoke	902710
902720	Chromatographs, etc.	902720
902730	Spectrometers, etc.	902730
902750	Other instruments using optical radiation	902750
902780	Other instruments for physical or chemical analysis	902780

Note: n.e.c.: not elsewhere classified.
Source: Adapted from IMF Statistics (2021a), Table HS_LCT.

Annex 2 – IMF's Low Carbon Technology Product Table

HS2017	Description	HS2012
902790	Parts for instruments, incl. microtomes	902790
903149	Other optical instruments	903149
903180	Other measuring or checking instruments	903180
903190	Instruments, appliances and machines; parts and accessories for those measuring or checking devices of heading no. 9031	903190
903210	Thermostats	903210
903220	Manostats	903220
903289	Other automatic regulating, controlling instruments	903289
903290	Regulating or controlling instruments and apparatus; automatic, parts and accessories	903290
903300	Machines and appliances, instruments or apparatus of chapter 90; parts and accessories n.e.c. in chapter 90	903300

Note: n.e.c.: not elsewhere classified.
Source: Adapted from IMF Statistics (2021a), Table HS_LCT.

Appendix A - GTA nomenclature and description of selected instruments of intervention

GTA Nomenclature	GTA Correspondence	Chapter UNCTAD	NTM UNCTAD Nomenclature	Description
Financial Grant	L Subsidies (excluding export subsidies under P7)	L	L11 Grants (other than price support under L15)	L- A measure or practice by any level of government that involves a financial transfer attributable to an identifiable beneficiary or group of beneficiaries that creates or could potentially create an advantage for those beneficiaries. Such measures or practices are related to support to enterprises, including family enterprises. L11 - Monetary support in the form of one-off or recurrent non-repayable, interest-free transfers of public funds to enterprises, whether conditional or unconditional
Trade finance	P6 Export-support measures	P	P6 Export-support measures	P - Measures applied to exported goods by the Government of the exporting country. Financial contributions by a Government or public body, or by government entrustment or direction of a private body (direct or potential direct transfer of funds: for example, grants, loans, equity infusions, guarantees; government revenue foregone; provision of goods or services or purchase of goods; and payments to a funding mechanism), or income or price support, which confers a benefit and is contingent in law or in fact upon export performance (whether solely or as one of several conditions). P6 - Financial contributions by a Government or public body, or by government entrustment or direction of a private body (direct or potential direct transfer of funds: for example, grants, loans, equity infusions, guarantees; government revenue foregone; provision of goods or services or purchase of goods; and payments to a funding mechanism), or income or price support, which confers a benefit and is contingent in law or in fact upon export performance (whether solely or as one of several conditions).
State Loan	L Subsidies (excluding export subsidies under P7)	L	L12 Credit support (to an enterprise)	L - A measure or practice by any level of government that involves a financial transfer attributable to an identifiable beneficiary or group of beneficiaries that creates or could potentially create an advantage for those beneficiaries. Such measures or practices are related to support to enterprises, including family enterprises. L12 - Monetary support given by the Government to an enterprise in relation to borrowed repayable funds, whether in the form of direct lending at a lower rate of interest or assistance in securing or repaying funds borrowed from other sources.

Source: Own elaboration.

Appendix A - GTA nomenclature and description of selected instruments of intervention

GTA Nomenclature	GTA Correspondence	Chapter UNCTAD	NTM UNCTAD Nomenclature	Description
Export Ban	P3 Export licenses, export quotas, export prohibition and other restrictions other than sanitary and phytosanitary or technical barriers to trade measures	P	P31 Export Prohibition	P - Measures applied to exported goods by the Government of the exporting country. Financial contributions by a Government or public body, or by government entrustment or direction of a private body (direct or potential direct transfer of funds: for example, grants. P3 - Restrictions to the quantity of goods exported to a specific country or countries by the Government of the exporting country for reasons such as a shortage of goods in the domestic market, the regulation of domestic prices, prevention of anti-dumping measures or for political reasons. Trade-related investment measures in the form of export restrictions are included in this category; loans, equity infusions, guarantees; government revenue foregone; provision of goods or services or purchase of goods; and payments to a funding mechanism), or income or price support, which confers a benefit and is contingent in law or in fact upon export performance (whether solely or as one of several conditions). P31 - Prohibition of exports of certain products.
Import Tariff	Import Tariff	-	-	Charge levied on imports and listed in importing country's tariff schedules. Tariffs may be specific or ad valorem or a combination of the two (ad valorem with a specific minimum, or the greater of the two)

Source: Own elaboration.

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