MAIS PRODUÇÃO PLAN, POWERSHORING AND COMPARATIVE ADVANTAGES: FINANCING STRATEGIES FOR BRAZIL'S GREEN INDUSTRIAL POLICY[1,2]

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This paper analyzes how BNDES financing through the *Mais Produção Plan* (P+P) contributes to diversifying and increasing the complexity of Brazilian industry. It also investigates the powershoring strategy as a green industrialization approach for Brazil, leveraging the country's renewable energy matrix. Through a comparative analysis of the sectors funded by BNDES and Brazil's export profile using economic complexity indicators (Product Complexity Index, Opportunity Gain, and Revealed Comparative Advantage), the study assesses the effectiveness of P+P in promoting strategic sectors. The results show that BNDES has targeted investments toward more complex sectors, such as machinery, chemicals, and electronics, but still allocates a significant share to the lower-complexity agricultural sector. The study concludes that incorporating the powershoring strategy into BNDES's portfolio could enhance Brazil's industrial competitiveness by utilizing renewable energy to attract investments and promote the transition to a low-carbon economy.

Keywords: powershoring; *Mais Produção Plan*; economic complexity; BNDES; green industrialization; sustainable finance.

PLANO MAIS PRODUÇÃO, *POWERSHORING* E VANTAGENS COMPARATIVAS: ESTRATÉGIAS DE FINANCIAMENTO DE POLÍTICA INDUSTRIAL VERDE PARA O BRASIL

O artigo analisa como o financiamento do BNDES no Plano Mais Produção (P+P) contribui para a diversificação e o aumento da complexidade da indústria brasileira. Além disso, investiga, a partir da análise de seus setores estratégicos, o conceito de *powershoring* como estratégia de industrialização verde para o Brasil, que objetiva aproveitar as vantagens comparativas decorrentes da matriz energética renovável do país. Por meio da análise comparativa entre os setores financiados pelo BNDES e a pauta exportadora brasileira, utilizando indicadores de complexidade econômica (Índice de Complexidade do Produto, Ganho de Oportunidade e Vantagem Comparativa Revelada), o estudo avalia a eficácia do P+P na promoção de setores estratégicos para a industrialização e a diversificação das exportações para setores. Os resultados indicam que o BNDES tem direcionado investimentos para setores de maior complexidade, como máquinas, químicos e eletrônicos, mas ainda aloca uma parcela significativa para o setor agrícola, de menor sofisticação. O estudo conclui que incorporar a estratégia de *powershoring* ao portfólio do BNDES poderia ampliar a competitividade da indústria brasileira, aproveitando a disponibilidade de energia renovável para atrair investimentos e promover a transição para uma economia de baixo carbono.

Palavras-chave: *powershoring*; Plano Mais Produção; complexidade econômica; BNDES; industrialização verde; finanças sustentáveis.

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PLANO MAIS PRODUÇÃO, POWERSHORING Y VENTAJAS COMPARATIVAS: ESTRATEGIAS DE FINANCIAMIENTO PARA LA POLÍTICA INDUSTRIAL VERDE DE BRASIL

Este artículo analiza cómo el financiamiento del BNDES a través del *Plano Mais Produção* (P+P) contribuye a la diversificación y al aumento de la complejidad de la industria brasileña. Además, investiga la estrategia de *powershoring* como un enfoque de industrialización verde para Brasil, aprovechando la matriz energética renovable del país. A través de un análisis comparativo de los sectores financiados por el BNDES y el perfil exportador de Brasil, utilizando indicadores de complejidad económica (Índice de Complejidad del Producto, Ganancia de Oportunidad y Ventaja Comparativa Revelada), el estudio evalúa la eficacia del P+P en la promoción de sectores estratégicos. Los resultados muestran que el BNDES ha dirigido inversiones hacia sectores más complejos, como maquinaria, productos químicos y electrónicos, aunque todavía destina una parte significativa al sector agrícola, de menor sofisticación. El estudio concluye que incorporar la estrategia de *powershoring* al portafolio del BNDES podría aumentar la competitividad industrial de Brasil, utilizando la energía renovable para atraer inversiones y promover la transición hacia una economía de bajo carbono.

Palabras clave: *powershoring*; *Plano Mais Produção*; complejidad económica; BNDES; industrialización verde; finanzas sostenibles.

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1 INTRODUCTION

The 2008 financial crisis marked a sharp rupture in the hegemonic international defense of economic – both trade and financial – liberalization. Once the risks of full international capital mobility were exposed, concerns also arose regarding the vulnerabilities of globalized production chains.

China's emergence as a global power after two decades of offshoring by U.S. and European multinational corporations raised alarms about the capacity of developing countries to internalize productive technologies, especially as part of a cost-cutting strategy pursued by developed economies.

In an increasingly hostile international environment – exacerbated by events such as the war in Ukraine and the global COVID-19 pandemic – developed countries have turned to the idea of renationalizing or bringing their production chains closer to home, a movement known as *nearshoring*. In this context, the return of Donald Trump to the White House in 2025 has so far been characterized by an offensive against trade liberalization and the structuring of U.S. corporate production chains that benefit other countries.

On the private sector side, *nearshoring* is a strategy employed to mitigate the risks of supply chain disruptions. From a national policy perspective, industrial

policy has emerged as an attempt to resume a trend of satisfactory economic growth and to ease political, social, and economic tensions that have arisen due to stagnant real income and the sharp rise in inequality since 2008.

Since efforts to resume economic growth began in late 2021, developed countries have aggressively adopted measures to strengthen, protect, and repatriate their key industrial activities. These countries accounted for more than two-thirds of all industrial policy measures adopted in 2023. Among them, the European Union and the United States – along with China – implemented nearly half of all such measures (IMF, 2024).

Among the officially stated motivations, the most prominent are maintaining competitiveness (37%), addressing climate change (28%), and ensuring supply chain resilience (15%). In industrialized countries, the primary instruments employed to incentivize industry in 2023 were subsidies, export promotion measures, and public procurement policies. Conversely, developing countries implemented import barriers (especially in low-income nations), as well as subsidies and public procurement policies (IMF, 2024).

Moreover, the economic and political crisis in the Western axis is unfolding in a context of growing alarm over climate change and difficulty in establishing effective national policies to reduce greenhouse gas emissions and unlock financial flows for climate financing.

Nonetheless, even in the face of a weakening of global climate governance, national regulations on the productive and financial systems have advanced in many countries. Notable examples include the European Union's sustainable taxonomy and Brazil's regulated carbon market. These developments are increasing pressure on companies and financial institutions to decarbonize their operations, both to mitigate transition risks – posed by mounting regulations – and physical risks – caused by climate change-induced natural disasters.

The decarbonization challenge presents itself differently for industrialized nations and commodity-producing countries. For instance, Brazil ranks as the 7th largest absolute emitter of CO_2e and 4th in terms of per capita emissions. However, the sources of its emissions differ from those of the other top emitters. While emissions in other major emitting countries stem largely from industry and transportation – both energy- and hydrocarbon-intensive – Brazil's emissions originate mainly from deforestation and land-use change (46%) and agricultural activity (28%) (SEEG, 2023).

Latin America and the Caribbean enter this context of rising geopolitical tensions and global supply chain realignment following a decade of low growth rates (ECLAC, 2022). The region's Gross Domestic Product (GDP) exhibited

a 10.3% increase between 2013 and 2023, contrasting with the 17.1% growth recorded in the European Union and the 37.2% increase observed in North America. While China and the United States registred growth rates of 46.2% and 39.1%, respectively, during the same period, Brazil's economy underwent a contraction of 13.7% (World Bank, 2024).

These low growth rates are linked to the erosion of productive development policies and the region's specialization in low-tech sectors (ECLAC, 2022). From the late 20th century to the early 21st century, the region has experienced a strong trend of deindustrialization, marked by a decline in the share of manufacturing in national value-added – a trend depicted in table 1. The absence of policies to support high-tech sectors in which countries hold – or could develop – comparative advantages is thus one of the main factors contributing to the region's stagnated growth (ECLAC, 2022).

TABLE 1
Industry value added in GDP
(In %)

Group/country	1990	2000	2010	2020	2023
Regions					
Eastern and Southern Africa	27.8	26.70	27.60	25.43	25.13
Western and Central Africa	32.2	31.80	27.10	27.26	30.15
Sub-Saharan Africa	29.1	28.50	27.40	26.27	27.08
North America	34.9	22.90	19.90	17.64	-
Latin America and the Caribbean	32.5	29.50	29.10	29.02	31.04
East Asia and Pacific	35.5	34.00	35.80	34.25	34.63
Middle East and North Africa	55.5	45.40	47.2	34.62	40.64
European Union	-	25.15	22.62	22.07	23.25
South Asia	26.2	25.27	29.18	25.27	25.46
Countries					
United States of America	-	22.45	19.31	17.27	-
China	41.0	45.53	43.49	37.84	38.82
Brazil	-	23.01	23.27	19.51	22.26
Income Group					
Low-income countries	20.4	25.81	28.48	25.43	23.10
Middle-income countries	34.9	33.87	36.16	32.98	33.64
High-income countries	-	26.53	23.97	21.98	-
World	-	27.73	27.50	26.00	26.12

Source: World Bank.
Author's elaboration.

In this context, the transition to a low-carbon economy not only requires massive investments to shift energy matrices toward renewable sources but also the construction and adaptation of infrastructure and production chains capable of manufacturing the necessary technologies for this transition. Such technologies include batteries, transmission networks, carbon-neutral transportation logistics, and especially supply chains of green inputs, meaning those produced with renewable energy and minimal environmental and climate impact. It is estimated that this structural and productive transformation will require between 100 and 300 trillion US dollars by 2050 (Barclays, 2023).

Among the necessary investments are those related to the transformation of the industry's supply chain, including extractive industries and the agricultural sector, but most notably, the provision of renewable electricity. Electricity generation and distribution pose a significant challenge for most industrialized countries, particularly in Europe. This is due to the fact that, until now, financing efforts for electricity generation have focused on wind and solar energy, both of which are highly dependent on geographic factors and the climatic conditions of the regions where plants are installed.

In contrast to the year-round abundance of solar radiation in tropical countries, and considering that wind flows are strongly determined by geography, countries located further north face barriers to a complete energy transition due to the intermittency and unavailability of energy sources throughout the day and year.

Consequently, the energy transition appears to be delineating a novel configuration of comparative advantages with respect to natural resource availability. The factors influencing the security and growth of national economies are not limited to traditional resources such as fertile land and water; geographic factors, including a country's position in the globe, also play a significant role. Countries that already have predominantly renewable electricity mixes may benefit from a rare window of opportunity for industrialization, based on manufacturing production powered by renewable energy sources. This is the case for Brazil and other Latin American countries whose energy mixes are predominantly reliant on solar and wind energy.

Industrialization can be an opportunity not only for these countries to boost their economic growth and value-added production but also to accelerate the transition to a low-carbon economy. The potential positive impact of this initiative would be twofold: it would both decarbonize their own national economies and those of industrialized countries. Countries that combine renewable energy matrices with geographical proximity to consumer markets, in

particular, have the opportunity to leverage these comparative advantages to shift their production profile toward higher value-added goods.

The first impact – on their own economies – stems from the fact that the greenhouse gas (GHG) emissions profile of many of these countries differs from that of industrialized countries. While developed countries exhibit a strong prevalence of emissions from the energy and transport sectors, largely associated with industrial production, developing countries frequently demonstrate emissions tied to agriculture and land use change, often linked to deforestation and land degradation. Furthermore, these countries may benefit from the creation of jobs and productivity gains resulting from industrialization. Additionally, they can also promote regional economic integration and strengthen their position within global value chains (Arbache, 2025).

The second impact, on industrialized economies, is attributable to the relocation of production from countries and regions with energy matrices heavily dependent on fossil fuels to those with abundant renewable energy supply. This shift helps companies reduce emissions associated with their operations and adhere to emerging regulations and consumer demands, thereby mitigating the risks and costs associated with transitioning to a low-carbon economy.

The solution currently pursued by many European countries – especially in the aftermath of the energy security crisis caused by the war in Ukraine and the sanctions imposed on their primary energy supplier, Russia – is focused on the importation of renewable energy sources in transportable forms, such as green hydrogen and biofuels.

However, the exportation of renewable energy presents logistical challenges due to high costs, low competitiveness, and the lack of infrastructure capable of supporting these operations, such as pipelines. These challenges are further compounded when considering the feasibility of exporting energy from Latin America to Europe, due to high transport costs and low competitiveness compared to potential suppliers in North Africa (Arbache, 2025).

In the context of climate and geopolitical transition, it is imperative for Brazil to establish a new framework to rethink and finance low-environmental-impact and climate-resilient productive development, while also promoting the reduction of social and income inequalities. This approach offer alternatives to the rampant exploitation of productive lands and the agricultural expansion that has been a driving force behind deforestation.

In addition to the service sector, which has assumed an increasingly prominent role in value-added production due to the growing digitalization and complexity of productive technologies, the green industry has emerged as

a relevant alternative to predatory and highly emissive productive activities. As demonstrated by Gramkow and Romero (2021), complex products are associated with lower CO2e emission intensity relative to their economic value because their manufacturing processes are cleaner and have higher added value.

In this sense, powershoring emerges as an industrialization proposal for developing countries based on leveraging comparative advantages from a green energy matrix and the abundant availability of critical natural resources for the global low-carbon transition. Powershoring can therefore be used as an industrial promotion strategy based on the supply of renewable energy to produce medium- and high-value-added goods.

Accordingly, the first objective of this paper is to investigate powershoring as an industrialization strategy in terms of complexity, evaluating the potential for sophistication and diversification of Brazil's industry resulting from investments in the strategic sectors aligned with this approach. The second objective is to analyze the financing provided by (Banco Nacional de Desenvolvimento Econômico Social – BNDES) under the Mais Produção Plan (More Production Plan) from a complexity perspective, with the aim of understanding whether investments have been directed toward sectors and subsectors that increase the complexity and diversification of Brazilian industry. This will be achieved by comparing the data with the country's export profile.

The objective of this study is to understand how the P+P Plan contributes to achieving higher value-added and technologically sophisticated production and export models compared to those currently observed in Brazil. Furthermore, the study seeks to determine whether the P+P Plan leverages the comparative advantages and opportunities outlined by the powershoring approach and, if not, how this strategy could be incorporated into BNDES's financing portfolio through support for strategic sectors.

2 KEY CONCEPTS: POWERSHORING, MAIS PRODUÇÃO PLAN, AND ECONOMIC COMPLEXITY

To support the analysis of data, this section seeks to discuss the main concepts used throughout this empirical effort and how they relate to the objective of the study. First, we will examine the powershoring strategy and the key features of this approach to promoting a green industrial policy. Then, we briefly describe the Mais Produção Plan within the broader framework of the Nova Indústria Brasil (New Industry Brazil), and the role and significance of BNDES financing in materializing the neo-industrialization policy. Lastly, we discuss the concept of economic complexity and how it can be applied to the analysis of industrial policies.

2.1 Powershoring

The concept of powershoring emerges as a strategy for productive development in Brazil that can be applied to boost green industrialization. This strategy aligns with global demands for sustainability, energy security, and economic efficiency, while capitalizing on the country's comparative advantages in this scenario. Powershoring refers to the decentralization of the production of energy-intensive goods to geographies that offer clean, secure, affordable, and abundant energy, in addition to proximity to large consumer markets (Arbache, 2022).

This strategy deviates from other approaches, such as nearshoring or reshoring, by emphasizing renewable energy as the central factor in attracting industrial investment (Arbache, 2022). In the case of Brazil, the country possesses a predominantly renewable energy matrix, particularly hydroelectric, solar, wind, and biomass energy, which places it in a favorable position to attract investments in energy-intensive sectors such as steel, aluminum, fertilizers, and the chemical industry.

The promotion of powershoring as a green industrialization strategy in Brazil holds considerable potential to impact the national economy, particularly in the context of transitioning to a low-carbon economy. By attracting industries that aim to reduce their carbon emissions and energy costs, the country can strengthen its participation in global value chains, create high-quality jobs, and enhance productivity.

Moreover, the strategy can contribute to the diversification of Brazil's industrial base by adding value to traditional commodities, such as minerals and agricultural products, through the production of more complex and sustainable goods. In this sense, it can help realign Brazil's productive structure by fostering domestic manufacturing of the inputs the country currently exports, thus increasing the human knowledge and technological capacity embedded in these products. This not only positively affects the trade balance and diversifies the production structure but also positions Brazil as a global player in the decarbonization agenda, aligning with international market demands for lower-carbon products.

However, the implementation of powershoring in Brazil faces substantial challenges, including the necessity for infrastructure investment, the complexity of integrating value chains, and overcoming technological barriers, as well as geopolitical and trade uncertainties. For example, port and logistics infrastructure must be modernized to facilitate exports of manufactured goods. Similarly, the power generation and distribution infrastructure must be reinforced to ensure adequate energy supply for industrial production.

Furthermore, the implementation of coordinated public policies is essential to create a favorable environment for foreign direct investment, including financing, tax incentives, and trade agreements. Coordination between different levels of government and the private sector will be crucial to maximize the benefits of powershoring while mitigating risks related to energy price volatility and geopolitical uncertainties.

In essence, powershoring represents a green industrial policy strategy for Brazil by promoting productive transformation on sustainable grounds. This approach differs from traditional methodologies by leveraging the country's comparative advantages in renewable energy. In contrast to conventional industrial policies, this approach does not necessarily rely on subsidies or protectionist measures, as its main pillars are attracting foreign direct investment and promoting exports.

In this regard, it reduces exchange rate and balance-of-payment risks that peripheral countries often face when implementing industrial policies. By integrating into global value chains through this strategy, Brazil can not only accelerate its economic growth but also contribute to the decarbonization of both the national and global economy.

2.2 Nova Indústria Brasil and the Mais Produção Plan

Nova Indústria Brasil (NIB) is a long-term industrial policy launched in 2024 by the Brazilian federal government with the goal of modernizing and strengthening the national industry by 2033. Inspired by mission-oriented industrial policy approaches, the initiative sets out goals and actions to foster the sustainable development of the industrial sector. NIB encompasses a set of actions and support instruments for the productive sector, aiming to boost technological progress, competitiveness and productivity, create quality jobs, leverage comparative advantages, and reposition the country in international trade (Hamatsu and De souza, 2024).

NIB's targets align with those established by the National Council for Industrial Development (CNDI), broken down into intermediate goals for 2026 and 2033, as follows:

- Mission 1: sustainable and digital agri-industrial chains for food, nutritional, and energy security;

  Targets: grow agri-industry GDP by up to 3% annually from 2024 to 2026 and up to 6% from 2027 to 2033; increase mechanization of family farming to 28% in 2026 and 35% in 2033, and technical improvement to 43% in 2026 and 66% in 2033, encouraging national supply of machinery and equipment and promoting regional development.

- Mission 2: a resilient health industrial complex to reduce SUS vulnerabilities and expand access to healthcare;

  Target: produce 50% of Brazil's health-related needs (medicines, vaccines, equipment, devices, materials, and technologies) domestically by 2026 and 70% by 2033.

- Mission 3: sustainable infrastructure, sanitation, housing, and mobility for productive integration and urban well-being;

  Targets: contract 2 million housing units under the Minha Casa Minha Vida program (500,000 with renewable energy systems) by 2026, and 6.9 million units (1.4 million with solar panels) by 2033; increase the share of domestically powered electric and hybrid vehicles in new vehicle sales to 3% in 2026 and 33% in 2033.

- Mission 4: digital transformation of industry to enhance productivity;

  Target: digitally transform 25% of Brazilian industrial firms by 2026 and 50% by 2033, ensuring national production participation in new technology segments.

- Mission 5: bioeconomy, decarbonization, energy transition, and energy security to ensure resources for future generations;

  Targets: promote green industry by reducing emissions intensity in line with sectoral targets under the Climate Plan (Plano Clima); increase the share of biofuels and electric sources in the transport energy matrix by 27% in 2026 and 50% in 2033; increase sustainable and technological use of biodiversity by 10% in 2026 and 30% in 2033.

- Mission 6: strategic technologies for national sovereignty and defense;

  Target: achieve 55% mastery of critical defense technologies by 2026 and 75% by 2033.

The financing arm of the NIB, the Mais Produção Plan (P+P), is a set of financial solutions expected to mobilize around BRL 300 billion by 2026 to enable the implementation of the industrial policy. Of this amount, the Brazilian Development Bank (BNDES) will be responsible for about BRL 250 billion in support of neo-industrialization projects (Brasil, 2024b).

The plan is jointly managed by BNDES, the Funding Authority for Studies and Projects (Finep), and the Brazilian Company for Industrial Research and Innovation (Embrapii). These institutions are joined by financing efforts from the Banco do Nordeste (BNB), Banco da Amazônia (BASA), Banco do Brasil (BB), and Caixa Econômica Federal (CAIXA). The strategy of the Mais Produção Plan

is guided by four main objectives: productivity; innovation and digitalization; decarbonization; and exports.

2.3 Economic complexity

In the analysis of industrial policies, economic complexity provides a framework for planning and evaluating industrial promotion based on the amount of knowledge embedded in the manufacturing process of products. In this approach, products are vehicles of knowledge, as they reflect the accumulated human development and application of knowledge required for their production.

Embedding knowledge into a product requires people who know how to make it. Since no single person can possess all the knowledge necessary to produce everything humans need, specialization allows us to collectively use vast amounts of knowledge, while each individual holds a small portion.

From this perspective, what enables modern society to function is the interaction among individuals and the formation of networks that allow for specialization and knowledge sharing. Thus, the amount of productive knowledge in a society depends not only on how much knowledge individuals possess, but on the diversity of knowledge among them. These individuals form organizations that enable their interactions, connecting to markets and other knowledge exchange spaces, such as universities and research centers (Hausmann et al., 2013).

The amount of productive knowledge in a society is reflected in the variety of firms it has, the diversity of occupations these firms require, and the extent of interactions between them. From this idea emerges the concept of economic complexity, a measure of how diverse and interconnected these networks are and how much productive knowledge a society mobilizes, as expressed in a country's production structure. Complex economies are those that incorporate and connect vast amounts of relevant productive knowledge through an extensive network of people to generate a diverse array of knowledge-intensive products (Hausmann et al., 2013).

Additionally, for firms to operate efficiently, a range of complementary systems, networks, and markets are required. Beyond the productive system itself, this includes: long-distance transport and logistics systems; urban transportation infrastructure for worker mobility; care services to reconcile reproductive and productive labor; health and safety systems; education and research centers for capacity building and innovation; and finally, energy and fuels – preferably renewable in the context of climate change – to support industrial processes.

Thus, analyzing economic complexity as a measure of economic development based on the knowledge embedded in a product aligns with the idea that

productive development must be accompanied by human and social development. Higher value-added production is, in this view, both a cause and a consequence of improved living conditions and greater opportunities for individuals in society. A holistic approach to productive development has increasingly shaped modern industrial policies, which aim not only to strengthen sectors or activities but also to advance social and environmental goals and principles.

The mission-oriented approach, developed by Mazzucato (2021), has become highly influential among policymakers in recent years for providing a framework to tackle social and environmental challenges while designing industrialization strategies. In Brazil, the NIB – within the broader Ecological Transformation Plan – is the main application of this industrial policy strategy.

In this regard, the economic complexity approach is a relevant tool for analyzing and evaluating 21st-century industrial policies – in this case, those implemented by Brazil. The subsequent section of this study will explore the core economic complexity theory concepts such as ubiquity, product complexity index, opportunity gains, and revealed comparative advantages. These concepts will allow for an assessment of how much an industrial policy advances in terms of knowledge development and the human and technological capital embedded in an economy.

Furthermore, analyzing industrial policies through the lens of economic complexity enables the assessment of not only established sectors but also those with the greatest potential to generate new productive capacities. Coupled with the analysis of the powershoring strategy in the Brazilian context, this approach is particularly useful to assess whether NIB's industrialization strategy leverages emerging comparative advantages associated with the energy transition and global geopolitics and moves the country toward a more sophisticated and diversified productive structure.

3 METHODOLOGY

The objective of this study is to examine two approaches to green industrialization proposed for Brazil, based on the analysis of economic complexity data. First, it seeks to identify the most strategic sectors for the powershoring approach, drawing from the relevant literature and data from the Annual Industrial Survey (PIA) conducted by the Brazilian Institute of Geography and Statistics (IBGE). Second, it aims to assess how industrial policy financing under the "Mais Produção" Plan (P+P) can foster improvements in complexity indicators compared to those associated with the current export basket.

Initially, using industrial expenditure data from the PIA, the sectors with the highest proportions of electricity spending relative to total production costs

were selected. These sectors are understood to be those that could benefit most economically from the powershoring opportunity, given the ongoing energy transition. Based on these data and insights from the literature, a taxonomy of the powershoring strategy was developed, classifying sectors according to the National Classification of Economic Activities (CNAE) 2.0 system.

In a second phase, a survey was conducted to identify sectors financed by the Brazilian Development Bank (BNDES) under the Mais Produção Plan, using public data from the BNDES "Painel Mais Produção" on direct operations (with available data referring to contracts signed up to July 2024). Using the corporate tax identification numbers (CNPJs) of the financed companies, a mapping of their primary CNAE codes was carried out, enabling statistical analysis of the sectors receiving the most resources.

Based on the CNAE class classification, the study aims to observe certain characteristics of BNDES financing patterns under the New Industry Brazil (NIB) policy, including convergence with the export basket, product complexity levels, and key opportunity gains for Brazil's industrial economic complexity. Lastly, from the powershoring perspective, we assess whether BNDES financing under the NIB's green industrialization policy has been leveraging Brazil's comparative advantages in renewable energy supply arising from the low-carbon transition and current geopolitical tensions.

Once the economic complexity datasets for the export basket, BNDES financing under P+P, and strategic powershoring sectors were built, these were compared using descriptive statistics to evaluate, in terms of economic complexity, how the two industrial policy approaches could influence the diversification and sophistication of Brazilian industrial production. In this sense, the study aims to understand how P+P financing encourages increased production complexity in Brazil, enabling the industry to acquire technical knowledge and technological capabilities to advance in the manufacturing of higher value-added products.

Thus, this work seeks to discuss green industrialization strategies through the lens of economic complexity, focusing particularly on the Opportunity Gain (OG), the Product Complexity Index (PCI), and Revealed Comparative Advantage (RCA) indicators.

3.1 Powershoring taxonomy

To construct the taxonomy of strategic sectors for the powershoring strategy in Brazil – given that powershoring involves seizing business opportunities arising from renewable energy generation and low-carbon manufacturing – two main data sources were used for sector selection and classification.

First, a survey of sectors mentioned in the powershoring literature was conducted. Drawing on the research and systematization of works by Arbache (2025), Arbache (2023), and Arbache and La Rovere (2023) – seminal studies in developing the powershoring concept and its applications – the sectors identified as potential beneficiaries of the powershoring strategy were selected.

In addition, data from the IBGE's Annual Industrial Survey (PIA) were used to inform the construction of the powershoring taxonomy. Considering that powershoring is especially attractive for energy-intensive sectors – due to Brazil's robust capacity to generate and distribute renewable electricity with low risk of scarcity or intermittency – those sectors with high energy requirements for production were also considered strategic.

To identify the most energy-intensive sectors in Brazil, the PIA data for 2024 were used. Based on these, sectors were classified according to the proportion of electricity costs relative to total production costs. Table 2, below, shows the average electricity expenditures as a share of total production costs by sector, classified according to the CNAE division.

TABLE 2
Average share of energy expenditures in total production costs by CNAE division
(In %)

CNAE division	Energy expenditures in production costs
Manufacture of rubber and plastic products	0.342
Manufacture of textiles	0.337
Manufacture of other products	0.296
Printing and reproduction of recordings	0.275
Manufacture of chemical products	0.261
Manufacture of furniture	0.247
Manufacture of food products	0.247
Manufacture of wood products	0.243
Metallurgy	0.236
Manufacture of beverages	0.233
Manufacture of machinery, appliances and electrical equipment	0.228
Manufacture of pulp, paper and paper products	0.215
Tanning and dressing of leather; manufacture of leather goods, travel articles and footwear	0.215
Manufacture of pharmaceutical and pharmaceutical-chemical products	0.193
Manufacture of non-metallic mineral products	0.172

(Continues)

(Continuation)

CNAE division	Energy expenditures in production costs
Manufacture of motor vehicles, trailers and semi-trailers	0.169
Manufacture of fabricated metal products, except machinery and equipment	0.167
Manufacture of computer, electronic and optical products	0.165
Manufacture of wearing apparel and accessories	0.160
Manufacture of tobacco products	0.157
Mining of non-metallic minerals	0.147
Manufacture of machinery and equipment	0.138
Manufacture of other transport equipment, except motor vehicles	0.108
Mining of metallic minerals	0.099
Manufacture of coke, refined petroleum products and biofuels	0.091
Mining of coal	0.086
Maintenance, repair and installation of machinery and equipment	0.051
Support activities for mineral extraction	0.008

Source: Annual Industrial Survey (PIA).
Author's elaboration.

The rubber and plastic manufacturing sector and the textile products manufacturing sector stand out as the most energy-intensive industries, with 34% and 33% of their total costs corresponding to energy expenditures, respectively. Among the sectors with higher added value, it is also possible to observe the significance of energy expenditures in the production costs of the chemical industry (26%), metallurgy (23%), and electrical machinery and equipment (23%) sectors. Thus, energy-intensive sectors that were not originally included in the taxonomy were added due to their potential to benefit from the powershoring strategy and position themselves in international markets as green products.

Finally, the powershoring taxonomy is illustrated below in table 3. The taxonomy was developed by combining the sectors and products identified in the literature with those that show higher electricity expenditures relative to other production costs. Products were grouped into categories based on strategic areas for powershoring. These categories, in turn, were classified into three broader sectors according to the CNAE system sections: Manufacturing Industries; Extractive Industries; and Agriculture, Livestock, and Forestry Production.

Moreover, the last two columns show the correspondence between the CNAE subsectors related to the analyzed product and the Harmonized System at the 6-digit level (HS-6), which allows for cross-referencing with product-level economic complexity data.

TABLE 3
Taxonomy of strategic sectors for powershoring

CNAE section	Category	Product	CNAE code	HS6 code
Manufacturing Industries	Metallurgy	Steel	24.21-1	730690
Manufacturing Industries	Metallurgy	Steel	24.22-9	730690
Manufacturing Industries	Metallurgy	Steel	24.23-7	730690
Manufacturing Industries	Metallurgy	Steel	24.24-5	730690
Manufacturing Industries	Metallurgy	Steel	24.31-8	730690
Manufacturing Industries	Metallurgy	Steel	24.39-3	730690
Manufacturing Industries	Metallurgy	Metallurgy	28.61-5	845490
Manufacturing Industries	Metallurgy	Aluminum	24.41-5	800120
Manufacturing Industries	Metallurgy	Ferroalloys	24.12-1	730690
Manufacturing Industries	Non-metallic Mineral Products	Glass	23.11-7	701328
Manufacturing Industries	Non-metallic Mineral Products	Glass	23.12-5	701328
Manufacturing Industries	Non-metallic Mineral Products	Glass	23.19-2	701328
Manufacturing Industries	Non-metallic Mineral Products	Fertilizers	20.12-6	310520
Manufacturing Industries	Chemical Industry	Fertilizers	20.13-4	310520
Manufacturing Industries	Chemical Industry	Fibers	24.12-1	730690
Manufacturing Industries	Chemical Industry	Solvents	20.73-8	320820
Manufacturing Industries	Chemical Industry	Rubber	22.21-8	392690
Manufacturing Industries	Chemical Industry	Rubber	22.23-4	392690
Manufacturing Industries	Chemical Industry	Rubber	22.22-6	392690
Manufacturing Industries	Chemical Industry	Rubber	22.29-3	392690
Manufacturing Industries	Chemical Industry	Rubber	22.11-1	400610
Manufacturing Industries	Chemical Industry	Leather	15.40-8	640690
Manufacturing Industries	Non-metallic Mineral Products	Ceramics	23.41-9	381600
Manufacturing Industries	Non-metallic Mineral Products	Ceramics	23.42-7	690721
Manufacturing Industries	Non-metallic Mineral Products	Ceramics	23.49-4	854620
Manufacturing Industries	Non-metallic Mineral Products	Cement	23.20-6	252220
Manufacturing Industries	Non-metallic Mineral Products	Cement	23.30-3	382450
Manufacturing Industries	Textile Industry	Cotton	13.11-1	550810
Manufacturing Industries	Textile Industry	Synthetic fibers	13.13-8	550810
Manufacturing Industries	Textile Industry	Threads and yarns	13.14-6	550810
Manufacturing Industries	Textile Industry	Cotton	13.21-9	540752
Manufacturing Industries	Textile Industry	Other fabrics	13.54-5	560129
Manufacturing Industries	Textile Industry	Other fabrics	13.59-6	560129
Manufacturing Industries	Textile Industry	Machinery	28.63-1	845090
Manufacturing Industries	Pulp and Paper	Pulp	17.10-9	480255
Manufacturing Industries	Pulp and Paper	Pulp	28.65-8	844399

(Continues)

(Continuation)

CNAE section	Category	Product	CNAE code	HS6 code
Manufacturing Industries	Pulp and Paper	Pulp	17.41-9	481820
Manufacturing Industries	Renewable Energy	Solar Energy	27.31-7	850110
Manufacturing Industries	Renewable Energy	Wind Energy	27.31-7	850110
Manufacturing Industries	Biofuels	Ethanol	19.31-4	292910
Manufacturing Industries	Biofuels	Biodiesel	19.32-2	292910
Manufacturing Industries	Biofuels	HVO	19.32-2	292910
Manufacturing Industries	Biofuels	Biogas	19.32-2	292910
Manufacturing Industries	Biofuels	Biomethane	19.32-2	292910
Manufacturing Industries	Biofuels	SAF	19.32-2	292910
Manufacturing Industries	Biofuels	e-Methanol	19.32-2	292910
Manufacturing Industries	Transportation	Electric vehicles	29.10-7	870321
Manufacturing Industries	Transportation	Electric vehicles	29.41-7	870821
Manufacturing Industries	Transportation	Electric vehicles	29.45-0	870821
Manufacturing Industries	Transportation	Batteries	27.21-0	850730
Manufacturing Industries	Transportation	Batteries	27.22-8	850730
Manufacturing Industries	Electrical Machinery and Equipment	Home appliances	27.51	851679
Agriculture, Livestock, and Forestry Production	Bioenergy	Forest biomass	02.10-1	440398
Extractive Industries	Critical Minerals	Lithium	07.29-4	260300
Extractive Industries	Critical Minerals	Copper	07.29-4	260300
Extractive Industries	Critical Minerals	Niobium	07.29-4	260300
Extractive Industries	Critical Minerals	Rare Earths	07.29-4	260300
Extractive Industries	Critical Minerals	Cobalt	07.29-4	260300
Extractive Industries	Critical Minerals	Nickel	07.29-4	260300
Extractive Industries	Critical Minerals	Vanadium	07.29-4	260300
Extractive Industries	Critical Minerals	Graphite	08.99-1	252510
Extractive Industries	Critical Minerals	Manganese	07.23-5	260300
Extractive Industries	Critical Minerals	Aluminum	07.21-9	260300

Author's own elaboration.

3.2 BNDES financing in the Mais Produção Plan

For the quantitative analysis of BNDES financing in the Mais Produção Plan, data on approved investments under the NIB framework were used, made available through the Mais Produção Panel (BNDES, 2024). Based on the BNDES direct operations data for the Mais Produção Plan between 2023 and 2024, a database was created with the companies financed by BNDES in P+P, obtaining disaggregated information on the amount financed by CNPJ in reais. By researching the CNPJs on the Federal Revenue Service website, information on the main CNAE codes of the financed companies was added.

Although the P+P program is supported by other Brazilian Development Financial Institutions (DFIs), such as Finep, BASA, and BNB, this study focused on BNDES due to scope limitations and because the most significant contributions to the total financing within the NIB are from this institution (R$ 250 billion of the R$ 300 billion total).

3.3 Brazil's exports

For comparing the complexity indicators of BNDES financing with Brazil's export agenda, a database was created from the Foreign Trade data of the Ministry of Development, Industry, and Commerce (MDIC) for 2024. Export data is provided by MDIC disaggregated by product according to the NCM (Mercosur Common Nomenclature) classification. To align and compare BNDES data with export data, the correspondence dictionary between the NCM and CNAE 2.0 systems, provided by IBGE, was used.

3.4 Economic complexity

To analyze export data, BNDES financing, and the taxonomy of powershoring, data from Harvard's Atlas of Economic Complexity for Brazil in 2022 was used as a source of data for complexity parameters by product, as this is the most recent year with available data.

The complexity approach considers the products that a society or region produces as indicators of accumulated productive knowledge, based on the diversity and ubiquity of its export products.

The number of countries producing a specific product p is used as a measure of ubiquity. The more countries that produce a product, the more "ubiquitous" it is. Diversity, in turn, is a measure of how many different types of products a country is capable of manufacturing. The production of a good requires a specific set of know-how; therefore, a country's total diversity is another way of expressing the amount of collective know-how existing within the country (Hausmann et al., 2013).

Considering a matrix M_{cp} where the rows represent different countries and the columns represent different products, the value of a specific point in the matrix is 1 if country c produces p, and 0 otherwise. In this case, we can measure diversity and ubiquity by summing the rows and columns of this matrix, mathematically defined as:

$$Diversity = k_{c,0} = \sum_{p} M_{cp} \quad (1)$$

$$Ubiquity = k_{p,0} = \sum_{c} M_{cp} \quad (2)$$

Economic complexity is calculated from the equations of diversity and ubiquity:

$$k_{c,n} = \left(\frac{1}{k_{c,0}}\right)\sum_{p} M_{cp}\left(\frac{1}{k_{p,0}}\right)\sum_{c} M_{c'p}k_{c',n-2} \quad (3)$$

The Product Complexity Index (PCI) measures a ranking of diversification and sophistication of the knowledge required for the development of a product. It is calculated based on how many countries produce the given product and its complexity. The mathematical representation to calculate the PCI can be described as:

$$\widetilde{M^{P}}_{p,p'} \equiv \sum_{c} \frac{M_{cp}M_{cp'}}{k_{c,0}k_{p,0}} \quad (4)$$

Where M_{cp} is a binary matrix that indicates whether country c exports product p.

The concept of Opportunity Gain (OG) evaluates the potential for future development by investing in strategic products. Products with high opportunity gain are linked to more complex sectors and can pave the way to produce even more sophisticated goods, promoting diversification and long-term economic growth. Opportunity gain is calculated as:

$$OG_c = \sum_{p} \frac{\phi_{p,p'}}{\sum_{p^n}\phi_{p^n,p'}}\left(1 - M_{cp'}\right)PCI_{p'} \quad (5)$$

Where $\frac{\phi_{p,p'}}{\sum_{p^n}\phi_{p^n,p'}}$ indicates the similarity between the production capabilities of country and those required to produce product p; ICP_C is the product complexity index for p and M_{cp} indicates whether the country c already exports the product p (1 if yes, 0 if no), so that the expression $1 - M_{cp'}$ selects only the products that the country does not produce. Higher values of opportunity gain indicate that the product is close to more complex products and/or more complex products.

Revealed Comparative Advantage (RCA) is a measure to evaluate whether a particular country is an exporter of a given product, meaning it exports more than the proportional share. It is calculated as the ratio between the product's share in national exports and the product's share in global trade. If the RCA is greater than 1, it indicates that the country exports that product in a proportion greater than the global average and has a revealed comparative advantage in that product. This is a measure used to identify sectors and products where the economy is already competitive.

RCA can be calculated as:

$$RCA_{cp} = \frac{\frac{X_{cp}}{\sum_p X_{cp}}}{\frac{\sum_c X_{cp}}{\sum_{c,p} X_{cp}}} \quad (6)$$

Where X_{cp} is the value of exports of product p by the country c; $\sum_p X_{cp}$ is the total exports of the country c; $\sum_p X_{cp}$ is the total global exports of product p; and $\sum_{c,p} X_{cp}$ is the total global exports of all products. If $RCA_{cp} > 1$, it means the country has a comparative advantage in the product p.

4 RESULTS

To address the research questions, data from foreign trade, BNDES financing, and the powershoring taxonomy were cross-referenced with complexity indicators of the observed products and sectors. The results of this empirical exercise are presented in this section.

Initially, the export data of Brazil for 2024 by sector (CNAE division) is explored, focusing on the complexity of the export agenda. The degree of complexity was assessed using three complexity indicators (Product Complexity Index, Opportunity Gain, and Revealed Comparative Advantage) to understand the current level of diversification and sophistication of Brazilian industrial products in the global market.

Next, the same complexity indicators were used to analyze the BNDES financing data disaggregated by sector (CNAE division), in order to understand how the NIB has utilized its financing arm, the Mais Produção Plan (P+P), to contribute to the gain of complexity in the national industry. Additionally, the powershoring taxonomy of strategic sectors was used to analyze how industrial policy has explored the potential complexity gain derived from this industrialization approach.

4.1 Export agenda

The export data was analyzed based on the sectors of exported products and the total value exported. Table 4 below shows the total export values and the number of operations by sector (CNAE division). The food products, metallurgy, and vehicles sectors are the most significant, with total export values of R$ 19.5 billion, R$ 10.6 billion, and R$ 5 billion, respectively, but differing in the number of operations due to the higher average export value of the metallurgy sector compared to the others.

TABLE 4
Total exported value in 2024 by sector

CNAE division	Sector	Total exported (R$)	Number of operations	Average value (R$)
10	Food Products	19,570,095,208	75,285	259,947
24	Metallurgy	10,633,875,172	14,156	751,192
29	Vehicles	5,060,761,216	38,821	130,361
20	Chemicals	4,999,980,182	43,535	114,850
17	Paper	3,404,763,641	6,451	527,789
19	Petroleum Derivatives and Biofuels	2,841,323,610	7,248	392,015
28	Machinery and Equipment	2,583,326,472	36,381	71,008
30	Other Transport Equipment	1,084,856,501	768,000	1,412,574
15	Leather	768,074,684	17,007	45,162
22	Rubber and Plastics	681,079,867	22,018	30,933
12	Tobacco Products	579,210,602	322,000	1,798,791
27	Electrical Machinery, Apparatus, and Materials	572,369,776	12,369	46,275
25	Metal Products	514,922,625	30,050	17,136
21	Pharmaceuticals and Farmochemicals	420,651,972	6,388	65,850
31	Furniture	393,792,020	6,504	60,546
16	Wood	341,001,301	1,455	234,365
23	Non-metallic Minerals	334,490,399	4,526	73,904
14	Clothing and Accessories	207,654,910	16,514	12,574
26	Electronics and Optical Equipment	184,946,698	6,545	28,258
13	Textiles	99,246,993	5,253	18,893
32	Miscellaneous	94,329,547	5,271	17,896
11	Beverages	36,467,509	1,966	18,549
18	Recordings	269,576	26,000	10,368
Total		**55,407,490,481**	**358,859**	**154,399**

Source: Ministry of Development, Industry, and Commerce (MDIC).
Author's elaboration.

Regarding the complexity of the exported products from the manufacturing industry, the average Product Complexity Index (PCI) for Brazilian exports is 0.27, and the average Opportunity Gain (OG) is 0.58. This indicates that the export basket has relatively low complexity, but the products within it provide opportunities to explore more complex goods.

When analyzing the economic complexity indicators, Opportunity Gain (OG), and Revealed Comparative Advantage (RCA) by exporting sector, there is a correlation between the sophistication of exported products and the diversification of future possibilities (table 5 below). The Machinery and Equipment sector stands out with the highest PCI (1.24) and a high OG (1.19), indicating that

its exports not only involve greater technological knowledge but also open doors to the production of even more complex goods. The Vehicles sector shows a similar profile, with a complexity index of 0.97 and an opportunity gain of 0.96, in addition to having the second highest RCA (0.41), suggesting a relatively consolidated position of Brazil in this segment.

TABLE 5
Complexity indicators for export sectors

CNAE division	Product	Product complexity index	Opportunity gain	Revealed comparative advantage
10	Food products	-0.48	0.171	0.29
24	Metallurgy	0.29	0.609	0.36
29	Vehicles	0.97	0.966	0.41
20	Chemicals	0.46	0.691	0.40
17	Paper	-0.31	0.255	0.29
19	Petroleum and biofuel derivatives	0.27	0.583	0.43
28	Machinery and equipment	1.24	1.194	0.32
30	Other transport equipment	0.84	0.848	0.18
16	Wood	-0.33	0.314	0.39
23	Non-metallic minerals	0.57	0.762	0.29
14	Apparel and accessories	-1.13	-0.173	0.04
26	Electronic and optical equipment	1.19	0.922	0.12
13	Textiles	-0.30	0.361	0.23
32	Miscellaneous	0.34	0.638	0.13
11	Beverages	-0.50	0.121	0.10
18	Recordings	0.79	0.897	0.27
Average		**0.27**	**0.58**	**0.27**

Author's elaboration.

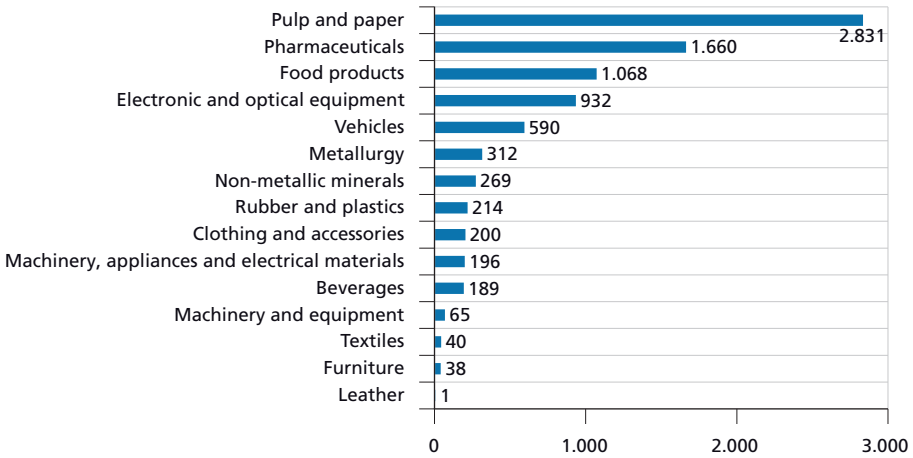
Naturally, there is a correlation between the sophistication of exported products and the diversification of future possibilities. The sectors with the highest complexity are related to the production of machinery and electronic or combustion-based equipment. Despite Brazil's relatively significant presence in the vehicle segment, the country still holds a smaller share of the machinery and equipment market, as measured by the Revealed Comparative Advantage (RCA).

Thus, machinery and vehicles lead in terms of complexity and diversification potential, reflecting their importance both for the export agenda and for industrial policy. Electronics and Metal Products also show high values, indicating the significant role of advanced industrial goods.

4.2 BNDES financing

BNDES financing under the Mais Produção Plan (P+P) totaled R$ 14.9 billion, with the majority allocated to the pulp and paper sector, which received R$ 2.831 billion – 19% of the total. Wholesale trade and the pharmaceutical chemicals sector followed, with R$ 1.7 billion (12%) and R$ 1.6 billion (11%), respectively. The analysis by CNAE division allows for a detailed view of the sectors to which the most heavily financed companies under the P+P belong, as illustrated in graph 1 below.

GRAPH 1
Most financed CNAE divisions by BNDES under the Mais Produção Plan in 2024
(In millions of R$)



Source: BNDES.
Author's elaboration.

The pulp, pharmaceutical, and biofuel-producing sectors received the largest share of the program's funding, followed by the food products and information technology and electronics sectors. When examining the data disaggregated by CNAE division, we also observe a significant allocation of resources to service-providing companies, such as office and financial services.

Below are the data on the complexity of BNDES financing by sector (table 6). Machinery and chemicals are the most complex sectors among those financed by BNDES under the P+P program, and they show the highest opportunity gains (0.901 and 0.999, respectively). These are the second and third most heavily funded sectors by BNDES, indicating a strategic focus on more complex sectors with greater diversification potential. Vehicles and electronics also stand out in terms of complexity and opportunity gains, reinforcing the emphasis on strategic sectors with higher technological sophistication.

TABLE 6
Complexity indicators for sectors financed by BNDES under the P+P program

CNAE division	Product	PCI	OG	RCA	**Total financed (million R$)**
17	Pulp and paper	0.778	0.769	0.944	**2,831**
21	Pharmaceutical and pharmaceutical chemicals	1.396	1.153	0.063	**1,660**
10	Food products	-0.731	-0.016	0.719	**1,068**
26	Electronic and optical equipment	1.359	0.802	0.027	**931**
29	Vehicles	1.126	1.039	0.497	**590**
24	Metallurgy	-0.291	0.136	0.422	**311**
23	Non-metallic minerals	-1.403	-0.284	0.148	**268**
35	Electricity and gas	-0.213	0.287	0.198	**251**
22	Rubber and plastic	0.351	0.614	0.481	**214**
14	Apparel and accessories	-0.921	0.063	0.028	**200**
27	Electrical machinery, appliances and materials	0.909	0.990	0.497	**196**
11	Beverages	-1.757	-0.240	0.060	**189**
28	Machinery and equipment	0.982	1.081	0.000	**65**
13	Textiles	-1.877	-0.298	0.752	**40**
31	Furniture	0.288	0.383	0.138	**37**
15	Leather	0.226	0.681	0.165	**1,3**

Source: BNDES (2024).
Author's elaboration.

The pharmaceutical chemicals, electronic equipment, and vehicle sectors are the most complex among those most financed by BNDES, followed by machinery and equipment. Medium-complexity sectors such as pulp and paper, rubber and plastic, and furniture also received significant funding. Lower-complexity sectors such as beverages, apparel, and textiles received proportionally less financing, except for food products, metallurgy, and non-metallic minerals.

At this point, it is important to note that the P+P program also aims to finance decarbonization projects and productivity improvements in established sectors of the Brazilian economy. This may explain the funding directed towards lower-complexity sectors that are nevertheless essential for industrial production, such as electricity and gas. Thus, a trend can be observed in BNDES financing decisions: prioritizing high-complexity sectors with high opportunity gains, in alignment with the neo-industrialization policy. This reflects a financial incentive towards more sophisticated sectors that can contribute to a more diversified Brazilian export portfolio.

Furthermore, the positive results in terms of opportunity gain suggest that the financed sectors and products may bring additional benefits by moving the Brazilian industry closer to the ability to produce more complex products or a greater variety of such products.

4.3 Divergence between the complexity of BNDES financing and the export portfolio

When comparing the complexity of sectors financed by BNDES under the P+P program with those in Brazil's export portfolio, it is noticeable that the average Product Complexity Index (PCI) of BNDES financing (0.08) is significantly lower than the average PCI of Brazilian exports (0.41). However, when disaggregating this average by sector within the manufacturing industry, it becomes evident that the products within the financed sectors are more complex than those in the export portfolio (table 7).

TABLE 7
Average Product Complexity Index (PCI) by sector for BNDES financing and exports

CNAE division	Sector	Amount financed (R$ million)	PCI – BNDES	PCI – Exports	Difference
21	Pharmaceutical chemicals and pharmaceuticals	1,660	1.396	0.829	0.567
26	Electronic and optical equipment	931	1.359	1.189	0.17
29	Vehicles	590	1.126	0.968	0.158
28	Machinery and equipment	65	0.982	1.244	-0.262
27	Electrical machinery, appliances and materials	196	0.909	0.788	0.121
17	Pulp and paper	2,831	0.778	-0.313	1.091
22	Rubber and plastics	214	0.351	0.468	-0.117
31	Furniture	37	0.288	0.295	-0.007
15	Leather	1	0.226	-0.105	0.331
35	Electricity and gas	251	-0.213	-	-
24	Metallurgy	311	-0.291	0.293	-0.584
10	Food products	1,068	-0.731	-0.477	-0.254
14	Apparel and accessories	200	-0.921	-1.131	0.21
23	Non-metallic minerals	268	-1.403	0.565	-1.968
11	Beverages	189	-1.757	-0.500	-1.257
13	Textiles	40	-1.877	-0.304	-1.573

Source: BNDES (2024).
Author's elaboration.

Among the more complex sectors financed by BNDES, the complexity of the financed products is, on average, higher than that of exported products. In this regard, pharmaceutical chemicals, electronic equipment, and vehicles stand out. A notable exception is the machinery and equipment sector, where the average complexity of the financed products is lower than that of the exported ones. Pulp and paper products, the most financed sector, show a significant positive difference between the PCI of the financed and exported products.

Among the less complex sectors, however, this pattern is reversed: the products financed by BNDES tend to have a lower PCI than those in the export portfolio, with the sole exception of the apparel and accessories sector. Although there is no direct explanation for this pattern in the results, one possible reason could be the effort to decarbonize or increase the productivity of companies in these sectors, which have lower international competitiveness. Due to a selection bias, exporting companies may be, within the sector, those whose products have higher competitiveness and added value.

Regarding opportunity gain, the BNDES average (0.44) is lower than the overall average for exports (0.519), but similar to the average for manufactured exports (0.453), indicating that the products financed by the bank have similar potential for future diversification when compared to the export structure of the manufacturing industry (see table 8 below).

TABLE 8
Average opportunity gain, by sector, for BNDES financing and exports

CNAE Division	Sector	Amount financed (R$ million)	Opportunity gain – BNDES	Opportunity gain – Exports	Difference
21	Pharmaceutical chemicals and pharmaceuticals	1,660	1.153	0.862	0.291
28	Machinery and equipment	65	1.081	1.194	-0.113
29	Vehicles	590	1.039	0.966	0.074
27	Electrical machinery, appliances, and materials	196	0.990	0.860	0.130
26	Electronic and optical equipment	931	0.802	0.922	-0.120
17	Pulp and paper	2,831	0.769	0.255	0.514
15	Leather	1	0.681	0.396	0.285
22	Rubber and plastics	214	0.614	0.659	-0.045
31	Furniture	37	0.383	0.440	-0.057
35	Electricity and gas	251	0.287	-	0.287
24	Metallurgy	311	0.136	0.609	-0.474
14	Apparel and accessories	200	0.063	-1.131	1.194
10	Food products	1,068	-0.016	-0.477	0.461
11	Beverages	189	-0.240	0.121	-0.361
23	Non-metallic minerals	268	-0.284	0.762	-1.046
13	Textiles	40	-0.298	0.361	-0.659
Average		**-**	**0.447**	**0.453**	**-**

Source: BNDES (2024).
Author's elaboration.

In this regard, the pharmaceutical chemicals, machinery, and vehicles sectors emerge as those with the greatest potential to foster industrial diversification and increased complexity through financing under the P+P program. Other sectors

with high opportunity gain include electrical appliances, electronic equipment, and pulp and paper. In these sectors – except for machinery and equipment – the products financed by BNDES show higher opportunity gain compared to those in the export portfolio.

Finally, an analysis of the financed and exported sectors in terms of revealed comparative advantage (RCA) shows that BNDES allocated most of its P+P resources to sectors in which Brazil already holds a relatively strong position in the global market, such as pulp and paper and food products (table 9). Within these high-RCA sectors, the products financed tend to be more competitive in global trade than those currently exported. This suggests that the P+P program aimed to invest in sectors where Brazil already has a strong international presence, but focused on products with higher competitiveness than those that are currently exported.

TABLE 9
Average Revealed Comparative Advantage (RCA) by sector, of BNDES financing and exports

CNAE division	Sector	Amount financed (R$ millions)	BNDES RCA	Export RCA	Difference
17	Pulp and Paper	2,831	0.944	0.291	0.653
13	Textiles	40	0.752	0.226	0.525
10	Food Products	1,068	0.719	0.293	0.425
27	Electrical Machinery and Equipment	196	0.497	0.238	0.259
29	Vehicles	590	0.497	0.412	0.084
22	Rubber and Plastic	214	0.481	0.257	0.224
24	Metallurgy	311	0.422	0.360	0.062
35	Electricity and Gas	251	0.198	-	0.198
15	Leather	1	0.165	0.226	-0.061
23	Non-metallic Minerals	268	0.148	0.291	-0.143
31	Furniture	37	0.138	0.309	-0.170
21	Pharmaceutical Chemicals	1,660	0.063	0.226	-0.164
11	Beverages	189	0.060	0.103	-0.043
14	Clothing and Accessories	200	0.028	0.038	-0.010
26	Electronic and Optical Equipment	931	0.027	0.119	-0.092
28	Machinery and Equipment	65	0.000	0.324	-0.323

Source: BNDES (2024).
Author's elaboration.

At the same time, among those sectors with lower RCA, where the country has no significant relative presence, BNDES has sought to finance products in which Brazil still has less competitiveness than the products it exports in these sectors. In other words, the results indicate that BNDES financing under the P+P

program has combined efforts to strengthen those sectors and products where Brazil is competitive, while also aiming to diversify Brazilian production by engaging industries and products where the country has a lower revealed comparative advantage.

Looking at the financing and export data in relation to their complexity indicators, we can conclude that BNDES is more oriented towards highly complex products compared to Brazilian exports, financing products with high potential for production diversification in strategic sectors such as machinery, vehicles, and pharmaceuticals. Additionally, there is a tendency to direct financing towards sectors with higher opportunity gains, thus increasing the capacity to generate new productive opportunities in the long term. In this same sense, the analysis of the revealed comparative advantages suggests that P+P has sought to strengthen the competitiveness of products where Brazil already has relevance in the global supply while also aiming to explore new markets where it has not yet played a significant role on the global stage.

These results indicate that P+P has succeeded in investing in sectors that promote the sophistication of the manufacturing industry and diversify the industrial production basket. The data suggests that, intentionally or not, the development bank has sought a balance between markets already conquered and those yet to be explored, which may guarantee a flow of resources from the increased competitiveness of exports, strengthening an industrial policy strategy with minimal impact on the balance of payments. This characteristic may be even more relevant in scenarios of currency devaluation, allowing a flow of reserves from the most competitive sectors to strengthen those that are less competitive by providing access to imported technology and inputs.

4.4 Powershoring: complexity of strategic sectors

Next, we analyze how powershoring can contribute to increasing the complexity of the Brazilian economy based on products mapped in the taxonomy as potential beneficiaries of a policy that would leverage renewable energy as an asset to attract manufacturing industries. To this end, sectors were cross-referenced with the complexity database to obtain the economic complexity indicators from the powershoring approach.

Among the strategic transformation industry products mapped by powershoring, those with high complexity include metallurgy, rubber, and biofuels. With intermediate complexity, the sectors of vehicles, ceramics, glass, and pulp and paper stand out, as well as household appliances and machinery (table 10).

TABLE 10
Product complexity index of the powershoring taxonomy

Product	Product complexity index (average)	Product	Product complexity index (average)
Metallurgy	1.217	Pulp and Paper	0.712
Rubber	1.117	Household Appliances	0.674
Biodiesel	1.068	Machinery	0.646
Biogas	1.068	Solvents	0.621
Biometane	1.068	Forest Biomass	0.195
Ethanol	1.068	Steel	0.182
HVO	1.068	Cotton	0.111
SAF	1.068	Synthetic Fibers	0.810
E-methanol	1.068	Ferroalloys	0.490
Batteries	1.009	Fibers	0.490
Vehicles	0.960	Cement	0.430
Ceramics	0.891	Fertilizers	-0.117
Glass	0.717		

Author's elaboration.

Textile products exhibit the lowest potential for complexity gain, as do steelmaking and fertilizers. The results for opportunity gain show a similar pattern (table 11 below).

TABLE 11
Opportunity gain of powershoring sectors

Product	Opportunity gain	Product	Opportunity gain
Metallurgy	1.217	Glass	0.717
Rubber	1.117	Pulp	0.712
Biodiesel	1.068	Household Appliances	0.674
Biogas	1.068	Machines	0.646
Biometane	1.068	Solvents	0.621
Ethanol	1.068	Forest Biomass	0.195
HVO	1.068	Steel	0.182
SAF	1.068	Cotton	0.111
e-methanol	1.068	Synthetic Fibers	0.81
Eatteries	1.009	Ferroalloys	0.49
Electric vehicles	0.960	Fibers	0.49
Ceramics	0.891	Cement	0.43
Glass	0.717	Fertilizers	-0.117
Pulp	0.712		

Source: Atlas of Economic Complexity.
Author's elaboration.

Regarding the potential for advancement of powershoring in relation to Brazil's Revealed Comparative Advantage (RCA), it is observed that the strategic products in the approach exhibit a wide diversity of RCA levels. The approach includes products in which Brazil has high competitiveness in the global market, such as renewable energy and household appliances, as well as those with relatively low presence of Brazilian products, such as batteries, machines, and pulp (table 12, below).

TABLE 12
Revealed Comparative Advantage (RCA) of powershoring strategic sectors

Product	RCA
Cotton	0.143
Steel	0.309
Batteries	0.100
Biodiesel	0.21
Biogas	0.21
Forest Biomass	0.892
Biometane	0.21
Rubber	0.182
Pulp	0.122
Ceramics	0.494
Cement	0.131
Household Appliances	0.67
Wind and Solar Energy	0.840
Ethanol	0.21
Ferroalloys	0.309
Fertilizers	0.297
Fibers	0.309
Synthetic Fibers	0.222
HVO (Hydrotreated Vegetable Oil)	0.21
Lines and Wires	0.222
Metallurgy	0.79
Machinery	0.139

Source: Atlas of Economic Complexity.
Author's elaboration.

This aligns with the rationale behind powershoring as a strategy that can become economically self-sufficient, primarily through increased exports and foreign direct investment. Furthermore, it indicates that powershoring has the potential to diversify the Brazilian industrial production basket, striking a balance

between sectors where the country already has competitiveness and those where there is still room to advance.

Thus, it is concluded that powershoring presents itself as a strategy with the potential to increase the complexity of the Brazilian industrial and export agenda by promoting investment in strategic sectors for the energy transition, such as biofuels and batteries. While most sectors in the powershoring transformation industry are already covered by NIB financing, advances can be made in financing more innovative and challenging sectors for the country, such as aviation biofuels (SAF). Indeed, BNDES and Finep jointly launched a call for projects in this sector in 2024, with a total of R$ 6 billion in resources for projects, R$ 3 billion from BNDES and R$ 3 billion from Finep (BNDES, 2024b).

The powershoring approach can also contribute to the prioritization of P+P financing by adding those energy-intensive sectors that are internationally competitive and whose exports can be boosted through the attraction of investments, both domestic and international, for the decarbonization of these industries through the availability of renewable energy.

Examples of sectors and products that have high complexity and are energy-intensive include: rubber and plastics; chemicals, metallurgy; machinery and electrical appliances; paper and pulp; pharmaceuticals; vehicles; and machinery and equipment. Many of these sectors are already covered by P+P financing, such as paper and pulp and pharmaceuticals, the two most financed sectors in the program.

However, the powershoring analysis can contribute to policymaking by including in the list of sectors financed the more traditional products manufactured with clean energy, such as steel and textiles, as well as those that are close to our export agenda but are advanced in innovation, such as biofuels and renewable energy batteries.

Furthermore, the industrial decarbonization effort involves reducing emissions from sectors considered “hard to abate”, those in which it is difficult to reduce emissions from their industrial process, indicating the opportunity for Brazil to enable the reduction of emissions from these sectors through manufacturing with renewable energy.

Nevertheless, it is important to note that the implementation of powershoring depends not only on the financing of these sectors, but also on the coordination between the three levels of government and agencies to enable a series of transformations in the fiscal and regulatory structure aimed at promoting the synergies and strategic business opportunities of these sectors and their value chains. In other words, it involves integrating the strategy of attracting

investment based on the supply of renewable energy as a key principle in the country's long-term planning.

Among the regulatory measures and public policies needed to enable powershoring in the context of neo-industrialization, the following stand out: financing of Research and Development (R&D) projects and integration with universities and research and innovation centers, in addition to other investments in human capital; promotion of a regulated carbon market to attract companies; an appropriate tax framework to encourage the production and distribution of renewable energy competitively, among others.

Moreover, a number of necessary measures within the framework of financing this policy include: the creation of a bankable project pipeline integrated with the objectives of the industrial policy based on powershoring; the establishment of investment funds and mapping of interested investors, and the adaptation of existing constitutional and development funds to support strategic investments; investments in the construction and management of electricity transmission lines; construction and improvement of infrastructure for supplying and transporting inputs and products to strategic sectors; promotion of favorable investment and trade agreements for powershoring and support for professional and general services sectors that assist industries.

In this regard, NIB aims to address several of these challenges for industrial development, such as improving the business environment, increasing competitiveness, enhancing human resources, promoting trade, and reducing regulatory inefficiencies in the country (such as intellectual property, taxation, and infrastructure) (Brasil, 2024a).

To achieve these goals, among the instruments of NIB for the financing and stimulation of the green industry, there are loans, technology transfer, grants, tax credits, adequate infrastructure, equity participation, regulation, local content requirements, technological orders, foreign trade, government purchases, preference margins, and public investment (Brasil, 2024a).

Brazil's industrial policy has already made advances in regulatory areas to enable green industrialization policies, such as the approval of the Regulated Carbon Market (PL 412/2022); the construction of the sustainable taxonomy; the availability of Guarantee Funds for the Nova Indústria Brasil program for Micro, Small, and Medium Enterprises; the development of the Single Foreign Trade Portal (Portal Único de Comércio Exterior, in Portuguese) by 2025 to streamline and facilitate foreign trade; the preparation of the National Quality Infrastructure Strategy (ENIQ); and the reduction in decision-making time for patent applications filed with National Institute of Industrial Property (INPI) under the 2023-2025 Action Plan of the National Intellectual Property Strategy.

In terms of financing actions outlined in the Mais Produção Plan, contributions to the Climate Fund (Fundo Clima), the main financing instrument for industrial decarbonization, are expected, as well as the structuring of investment funds focused on ecological transformation. Another important advancement is the creation of Credit Letters for Development (Letras de Crédito de Desenvolvimento – LCDs) in 2024, an instrument for raising funds to leverage financing for the industry through development banks.

5 CONCLUSION

This paper aimed to investigate how BNDES financing under the Mais Produção Plan (P+P) has been allocated to different sectors and subsectors, focusing on the complexity of the financed activities and how the P+P financing strategy contributes to the diversification of Brazil's export agenda. Furthermore, it sought to analyze how the powershoring strategy could contribute to increasing the complexity of Brazil's industrial agenda, particularly in the transformation industry, by exploring the country's comparative advantages linked to the reorganizations of global value chains driven by climate change and recent geopolitical tensions.

It is observed that BNDES financing promotes productive activities that have a higher level of complexity than what is observed in Brazil's export agenda, especially in the pharmaceutical, machinery and electronics, and paper and pulp sectors. The direction of the financing shows a dual dynamic: for those sectors where the country has a larger relative share in the global market, more competitive products are financed compared to the average of the products exported by the sector; on the other hand, in sectors with lower revealed comparative advantage, BNDES has financed even less competitive sectors than those exported, seemingly aiming to strengthen Brazil's industrial competitiveness in sectors that are not yet explored.

These results point to a direction towards more complex products and the diversification of the exported products, while reinforcing the competitiveness and productivity of the sectors where the country is already a global player. This approach may have some apparent advantages: increased competitiveness and potentially higher export volumes; an increase in the flow of foreign reserves needed for industrialization efforts; and a reduction in risks related to productive financing in new markets by anchoring investments in safer sectors.

Additionally, the fact that, within the most competitive sectors, products with higher complexity and opportunity gains are financed compared to exported products may indicate that investments are being made in the development of new products and services in the financed companies. Or it could also indicate

that decarbonization efforts are being made in exporting industries, which could increase their competitiveness and reduce transition risks in those sectors.

In this sense, powershoring appears as an approach with potential benefits in terms of economic complexity gains, should it be incorporated into Brazil's green industrialization policy. By combining the exploration of comparative advantages and the abundance of critical natural resources for the transition to a low-carbon global economy, powershoring could address the need for economic returns in the short and medium term, while creating opportunities to complexify Brazil's industrial production in the medium and long term. In this sense, there seem to be synergies between the P+P strategies and powershoring.

Additionally, strategic sectors for powershoring such as biofuels, batteries, and metallurgy represent significant opportunities for Brazil, as they combine decarbonization efforts, innovation, and the capture of new markets based on products in which Brazil already has experience. Indeed, P+P investments appear to be directed towards these sectors, with significant amounts of funding already disbursed and announced for innovation in these areas.

Unlike Nova Indústria Brasil, which aims to promote productive and social development through missions involving the strengthening of specific sectors, the powershoring approach is based on the supply of low-cost renewable energy as the central point for driving Brazil's industrialization in the 21st century, in order to attract foreign direct investment with the consequent increase in the competitiveness of Brazilian industry in a decarbonization scenario.

As evaluated in this paper, powershoring also has the potential to increase the complexity of the Brazilian economy by exploring high value-added and technologically sophisticated sectors that are key to the decarbonization of the global economy, such as aviation biofuels (SAF) and batteries. The advancement of Brazilian industry in these markets is not hard to imagine, given the country's experience with the production and innovation of similarly complex products, such as ethanol and green steel, and its availability of reserves of critical minerals for the energy transition.

Thus, as BNDES investments under P+P in 2024 progress in terms of technological sophistication and added value compared to products Brazil has specialized in over time, considering the central idea of powershoring to promote and attract investments through the supply of renewable energy could contribute to increased competitiveness, enhance long-term returns on financing, and overcome the export agenda of low value-added primary products.

If integrated into the green industrial policy financing planning by promoting the attraction of private and public investments, whether domestic or

international, this strategy could contribute to the funding of the industrial policy and leverage the resources mobilized within the Nova Indústria Brasil framework.

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