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SUSTAINABLE VALUE CHAINS

OPPORTUNITIES AND CHALLENGES OF PRODUCTIVE INTEGRATION AND DECARBONIZATION IN COLOMBIA, PERU, AND ECUADOR

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SUSTAINABLE VALUE CHAINS:

OPPORTUNITIES AND CHALLENGES OF PRODUCTIVE INTEGRATION AND DECARBONIZATION IN COLOMBIA, PERU, AND ECUADOR

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CREDITS

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FOREWORD

The countries of the Andean Region are facing a changing and challenging international scenario. As the region struggles to recover from the postpandemic crisis, which triggered one of the most severe recessions in its economic history, the international stage is being affected by a series of events that have disrupted the global productive dynamics.

These developments include digital transformation, which is significantly changing the way people, companies, and governments interact; geopolitical tensions; and, most importantly, the drive toward a green and sustainable transformation. Countries have adopted the Paris Agreement, a legally binding international treaty that includes commitments to reduce greenhouse emissions and to work together to adapt to and mitigate the consequences of climate change.

While the international scenario is challenging, this new context provides new opportunities for countries in the region to position themselves internationally in sectors with established and emerging comparative advantages alike. These opportunities could help establish a solid foundation for growth and sustainable development.

The Andean Region is in need of regaining a sustainable growth path. After growing at an average of 4.2 percent between 2000 and 2014, growth has slowed. According to the International Monetary Fund, the long-term growth outlook is 2.9 percent. In this context, insertion into global value chains is a pending task for the region. Latin America and the Caribbean have one of the lowest levels of trade openness of all developing regions and the Andean countries are no different.

However, this greater international insertion must take place within the framework of sustainable value chains that address the new climate challenges. In this context, around 17 percent of total greenhouse gas emissions in the Andean Region are associated with its export matrix, given the importance of animal food production and activities that use nonrenewable energy sources. It is worth mentioning that the countries of the region export a significant percentage of goods that are vulnerable to trade restrictions associated with decarbonization.

The purpose of this document is to identify opportunities linked to the development of sustainable value chains in three countries of the Andean Region: Colombia, Ecuador, and Peru. In order to develop a more in-depth perspective on the subject, the study focuses on four value chains: fisheries, textiles and apparel, plastics and rubber, and automotive. These sectors can play a key role in terms of both trade and decarbonization potential.

Developed jointly by the Andean Group and the Integration and Trade Departments of the Inter-American Development Bank (IDB), this report seeks to contribute ideas for reflection on the topics mentioned above. Consequently, this publication analyzes areas and policy options that can serve as points of reference and discussion on the productive performance—and the decarbonization—of these value chains.

We hope that this document will serve as a source for dialogue on the role of these value chains in the productive transition and that it will complement the Bank's efforts to assist our member countries in addressing the challenges and opportunities mentioned above and, in particular, to collaborate with them in achieving this common goal.

MIGUEL CORONADO
General Manager (Acting)
Andean Group Country Department

FABRIZIO OPERTTI
Manager
Integration and Trade Sector

1. INTRODUCTION

If current emission levels are maintained, it is estimated that global warming will exceed 1.5°C by 2030–2050 (IPCC, 2022). Although the contribution of Latin America and the Caribbean (LAC) to greenhouse gas (GHG) emissions is estimated at around 8.1 percent,[1] GHG emissions by LAC have increased by approximately 61 percent over the last 30 years (ECLAC, 2023). Moreover, LAC is one of the regions in which the impacts of climate change are being felt most strongly: 13 of the 50 most affected countries in the world are in Latin America (OECD, 2022).

In the specific case of the Andean Region,[2] around 17 percent of total GHG emissions are associated with the export matrix, given the importance of animal food production and activities that use nonrenewable energy sources (IDB, 2023). In this regard, climate change poses numerous challenges for the region's economies. The current levels of drought are impacting agricultural productivity, putting not only the food security of the population but also the public accounts at risk as a result of the decline in the gross domestic product (GDP) of each country.[3]

Several countries in the region depend on exports of agricultural products or fossil fuels,[4] which sharpens the need for them to diversify their productive structures and reorient them toward more-sustainable practices. According to recent estimates by the World Trade Organization (WTO), a 1°C increase in global temperatures will reduce annual export growth in developing countries by 2 to 5.7 percent (WTO, 2022).[5] In this context, climate change is expected to affect the structure of international trade and alter, among other things, trade transport routes and global value chains (GVCs).

Dolabella and Mesquita Moreira (2022) analyzed the contribution of trade policy to the carbon footprint[6] and found that at least half of the countries in the study[7] have lower tariffs on so-called "dirty products," i.e., those of which the production and transport are emissions intensive. This policy decision can ultimately be interpreted as a subsidy of trade emissions.

Actions based on new environmental considerations by both governments (such as the European Union's adoption of the Green Deal) and consumers will potentially reshape consumption, trade, and production patterns. This disruption will be exacerbated by a combination of trends that are driving a change in trade flows, notably increased interest in securing the supply of strategic goods,[8] new

1 GHGs are gases that accumulate in the atmosphere and absorb infrared energy from the sun, giving rise to the phenomenon known as the greenhouse effect and the consequent increase in the global temperature of the planet. The main GHGs in the Earth's atmosphere are water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3).

2 This report will analyze the cases of Colombia, Ecuador, and Peru.

3 According to Alejos (2021), for lower-middle-income and low-income countries, this contraction in public revenues will be equivalent to 0.8 and 1.1 percent of GDP, respectively.

4 Currently, 75 percent of total exports in the region are primary products and natural-resource-based manufactures (OECD, 2022).

5 These estimates are based on Dell *et al.* (2012), who show that the agricultural and light-industry sectors will be particularly affected.

6 This is an environmental indicator that reflects the total GHGs emitted as a result of the direct and indirect consumption of individuals, companies, or activities. It is measured in grams of carbon dioxide equivalent (gCO_2eq).

7 The following countries were analyzed: Colombia, Panama, Nicaragua, Chile, Honduras, El Salvador, Guatemala, Costa Rica, Jamaica, Dominican Republic, Mexico, Peru, Ecuador, Bolivia, Trinidad and Tobago, Paraguay, Uruguay, Venezuela, Argentina, and Brazil.

8 Such as rare earths or vaccines.

geopolitical tensions, and the development of shorter and more-agile and resilient supply chains (UNCTAD, 2020; McKinsey Global Institute, 2020; Ernst & Young, 2020).

Beyond disruption, this context presents numerous opportunities for Latin American companies to innovate, increase the level of their productivity, and compete successfully in an international environment that is converging toward net-zero emissions (a condition known as net-zero[9]).

Strengthening international insertion is a priority for the region's companies and governments, especially in the current context of high economic vulnerability. Greater integration with GVCs will bring important benefits not only in terms of diversification of production and trade, but also in terms of productivity gains,[10] knowledge and technology transfer, and generation of more and better jobs that support gender equity (World Bank, 2020; Antràs, 2019; Winkler & Rocha, 2019; Shepherd & Stone, 2012).

This GVC integration agenda is strongly linked to progress on the decarbonization agenda. The imminent global transition to carbon neutrality will create new winners and losers in global trade, which means that LAC companies will have to implement technological transformations so as to reduce emissions and take advantage of opportunities to integrate globally (Bataille *et al.*, 2021).

The imminent global transition toward carbon neutrality will create new winners and losers in global trade, implying that companies in Latin America and the Caribbean will need to face technological transformations to reduce emissions and thus, take advantage of opportunities to integrate globally.

In the case of the Andean Region, one of the sectors that will have the greatest impact on exports is oil, given the expected decrease in world demand that analysts predict for 2030 (BP, 2022; Alvik *et al.*, 2022; IEA, 2022b; McKinsey Global Institute, 2022; Rystad Energy, 2022). Oil is the highest value export stream for Ecuador and Colombia, with a total annual value of approximately US$24 billion in exports in 2019 for both countries. According to IDB (2023) at least 7.5 million jobs associated with fossil-fuel extraction and power-generation activities, as well as animal food production, are at risk of being lost by 2030.

Accordingly, companies in the region face the dual challenge of having to adapt as quickly as possible to new global scenarios in order to reduce their carbon footprint[11] and at the same time strengthen their international insertion in order to generate more and better jobs. In this context, the purpose of this paper is to identify new productive opportunities associated with the development of sustainable chains, focusing on three countries in the Andean region: Colombia, Ecuador, and Peru.

This study focuses on four value chains: fisheries, textiles and apparel, plastics and rubber, and automotive. These are particularly relevant because they have cross-border vertical relationships that generate regional and global value chains. They will also play a key role in terms of both trade and decarbonization potential.

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9 To maintain global warming below 1.5°C, the commitment is for global emissions to be reduced by about 45 percent by 2030 and to reach net zero by 2050. See more at https://www.iea.org/reports/net-zero-by-2050.

10 According to a recent study by the World Bank (2020), companies in developing countries can realize significant productivity gains from their participation in GVCs. A 1 percent increase in GVC participation is estimated to increase per capita income by more than 1 percent.

11 As of March 2023, of the top 2,000 companies listed on the New York Stock Exchange, 826 have net zero targets (Net Zero Tracker, 2023).

The study of the opportunities and obstacles that these sectors present, in terms of both trade integration and decarbonization, provides a broad and diverse picture of the state of the productive frameworks of the countries mentioned above. This in turn enables the identification of specific policy responses that promote the production and marketing of more-sustainable goods.

Likewise, decarbonization strategies for these sectors share many cross-cutting elements. These are important for achieving net zero emissions in these industrial subsectors as well as in a variety of other industries (Lechtenböhmer *et al.*, 2016; Bataille *et al.*, 2018; Rissman *et al.*, 2020; Bataille *et al.*, 2021).

This report is structured as follows: the first chapter describes the current situation regarding the level of trade integration and decarbonization challenges faced by the countries under study, as well as briefly characterizing the methodology used throughout the research. The second chapter identifies the main opportunities and develops the principles of a sustainable integration strategy for each of the three countries analyzed. The final chapter presents a set of policy recommendations.

Although Latin America and the Caribbean's contribution to greenhouse gas emissions is around 8.1%, these have increased by approximately 61% over the last 30 years.

2

STARTING POSITION

2. STARTING POSITION

LAC has a low level of integration with global markets. This is evident, for example, when the region is compared to developing regions in general in terms of trade openness. The region's trade openness index[12] for the period 2015–2021 averaged 47 percent, lower than that of regions with similar income levels in the Middle East and North Africa on the one hand and Europe and Central Asia and the other.[13]

The region's participation in GVCs can be measured using a variety of methods. By using data from multiregional input-output matrices, one way to measure GVC participation is by examining a country's linkages upstream in the value chain. Specifically, the percentage of foreign value added incorporated in a country's exports is calculated. Table 2.1 shows the simple averages of this measurement for three different time periods for the set of countries within each of the regions. Overall, the proportion has not changed much over time for LAC, while it has grown slightly in Asia and the European Union countries. In the 2017–2019 period, the exports of the average Latin American country incorporated 18.1 percent foreign value added, compared to 33.1 in the average Asian country and 43.3 in the average European Union country (Blyde & Trachtenberg, 2020).

Table 2.1. Foreign value added incorporated in exports (as a percentage of exports)

	Average 1990-1992	Average 2000-2002	Average 2017-2019
LAC	19.2%	18.2%	18.1%
ASIA	31.5%	32.8%	33.1%
UE	34.4%	37.7%	42.3%

Source: IDB with data from UNCTAD-EORA.

The Andean countries are no exception to this pattern (Table 2.2) and even show values below the LAC average. On average, barely 10 percent of foreign value was added to the region's exports in the period 1990–2019—the share in fact declined somewhat—except in the case of Peru, which shown an upward trend over the years.

12 This is understood as the sum of exports and imports of goods and services in relation to GDP.

13 In the Europe and Central Asia regions (where high-income countries were excluded), the average trade openness values for the period 2015–2021 were 53 and 59 percent, respectively.

Table 2.2. Foreign value added incorporated in exports (as a percentage of exports)

Region	Average 1990-1992	Average 2000-2002	Average 2017-2019
Bolivia	9.4%	8.2%	8.7%
Colombia	8.7%	12.7%	10.7%
Ecuador	11.4%	10.9%	9.0%
Peru	8.4%	8.2%	12.1%
Average Andean countries	9.5%	10.0%	10.1%

Source: IDB with data from Casella *et al.* (2019).

This exercise can be replicated at the regional level to evaluate the formation of regional value chains, examining the proportion of foreign value added that comes from the same region and is incorporated into a country's exports. In this case, the differences become even more evident for the Andean countries. For example, in the 2017–2019 period, exports from this region incorporated, on average, 3.2 percent of value added coming from LAC countries. In contrast, exports from Asia incorporated 20.4 percent of value added from the same region, while exports from European Union countries contained 22.7 percent of value added from those countries (IDB, 2023).

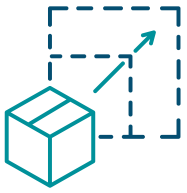
At the same time, the low levels of foreign direct investment (FDI) received by the region as it recovered from the COVID-19 pandemic[14] have not been able to exceed previous levels.[15] Similarly, the weight of incoming FDI flows in relation to GDP was equivalent to 2.9 percent, a value that is still below that observed average during the 2010s (3.5 percent). Considering that FDI inflows had been trending downward since 2014, this weak recovery shows how difficult it is for the region to position itself as an attractive destination for the establishment of new operations by transnational companies (ECLAC, 2022).

We now describe in detail the situation of the countries under study.

14 According to recent UNCTAD data, a total of US$142.794 billion was received, 40.7 percent higher than in 2020.

15 Data on FDI flows are from UNCTAD, https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=96740.

Colombia



Latin America and the Caribbean have one of the lowest trade openness of all developing regions, with a trade openness index of 47% for the 2015-2021 average, lower than other regions with similar income levels.

The foreign value added incorporated in exports reflects the value provided by intermediate products from abroad to the final product being exported. In the case of Colombian exports, this value is not only low, but has shown a decreasing trend over the last few years. This situation evidences Colombia's low incorporation in GVCs (10.7 percent of foreign value incorporated in exports between 2017 and 2019), which in recent years is still above the average for the Andean Region (10.1 percent) (Table 2.2).

Regarding GHG emissions, according to the World Bank the country emitted 187,339 kt of CO_2 equivalent (eq) in 2019,[16] which was 0.4 percent of total global emissions that year.[17] This represents an increase of 16% over the levels emitted in 2010. Although per capita emissions (1.6 t CO_2 eq per capita/year) were below both the global average value and those recorded by countries in Europe and North America,[18] the consequences of climate change pose a threat to Colombia. According to the Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM), historical evidence shows that over the last thirty years there has been a significant increase in the incidence of droughts and extreme rainfall; increases of 0.9°C by 2040 and 2.4°C by the end of the century in the country's average temperature are expected.[19]

Consequently, Colombia has made a commitment to reduce its emissions by 51 percent by 2030 and to achieve carbon neutrality by 2050.[20] Zero-emissions-modeling exercises for Colombia indicate that the carbon intensity of grid power generation should decrease by 98 percent by 2050 (Delgado *et al.*, 2020). This implies, for example, that 100 percent of the electricity supplied for the production of the four chains analyzed in this report should come from alternative energy sources.[21]

Beyond the long-term agenda, Colombia faces the need to initiate the transition to a lower carbon footprint in the short term not only because it is good for the environment, but also because it is beneficial for the economy. In particular, a significant fraction of exports is at risk in light of the adoption of sustainability-based trade restrictions by importing countries.

16 Measured in tons of carbon footprint (total GHG emissions).

17 See more at https://datos.bancomundial.org/indicator/EN.ATM.GHGT.KT.CE.

18 In 2019, CO_2 emissions per capita were 4.4 t globally while in the European Union and North America they were 6 and 15 t of CO_2 eq per capita, respectively (see more at: https://datos.bancomundial.org/indicador/EN.ATM.CO2E.PC?view=chart).

19 See more at: http://documentacion.ideam.gov.co/openbiblio/bvirtual/023731/TCNCC_COLOMBIA_CMNUCC_2017_2.pdf.

20 https://www.minambiente.gov.co/asuntos-ambientales-sectorial-y-urbana/colombia-reducira-en-un-51-sus-emisiones-de-gases-efecto-invernadero-para-el-ano-2030/. It is important to note that beyond Colombia's commitment to reducing its GHG emissions, achieving carbon neutrality also depends on the action taken by the other economies and countries with which Colombia interacts.

21 Colombia already has significant renewable energy resources in the form of hydropower (UPME, 2020), with great potential for nonhydropower renewables such as wind and solar (Rueda-Bayona *et al.*, 2019; Henao *et al.*, 2020; Galvís- Villamizar *et al.*, 2022; Moreno Rocha *et al.*, 2022).

Graph 2.1 characterizes Colombia's exports in terms of the relative GHG emission intensity (compared to the average emission intensity of those products produced in the United States, Germany, and Spain[22]) and a vulnerability index[23] that assesses the probability of destination countries' adopting trade restrictions linked to decarbonization.[24] The size of the bubbles reflects the value of exports in 2022 to mitigate the effects of COVID-19.

This analysis allows for the assessment of the exposure of Colombia's exports to potential trade restrictions, thus laying the foundation for advancing an agenda that seeks to minimize the impact on the most vulnerable sectors.

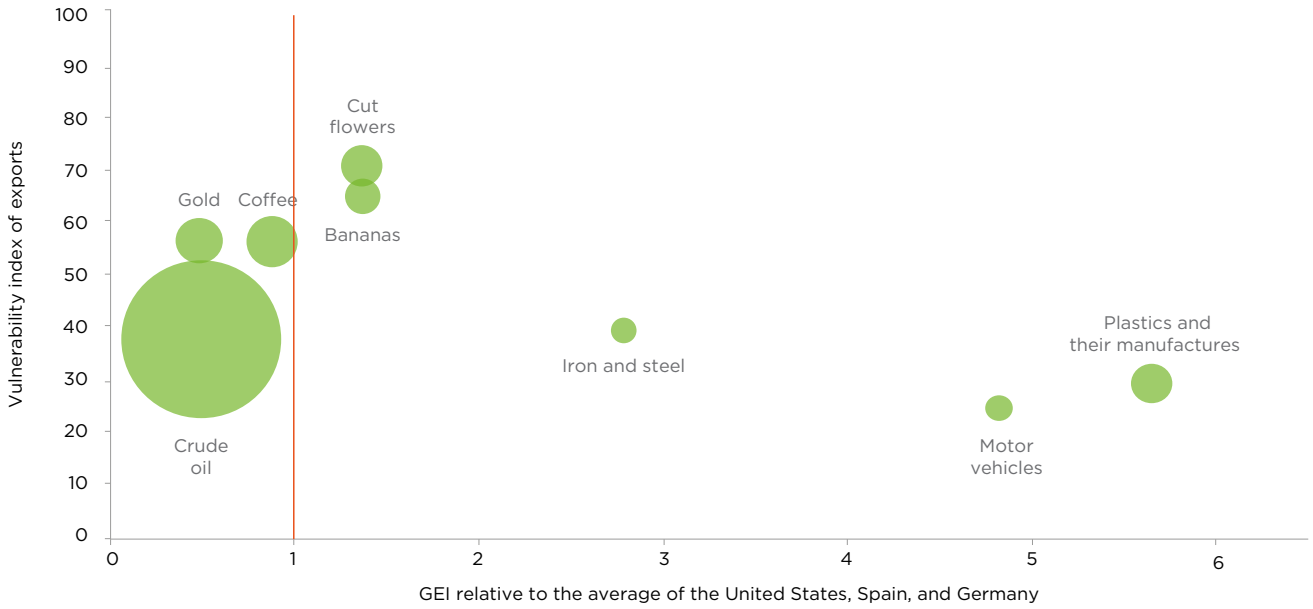
Several sets of products are identified as vulnerable. For instance, products related to plastics and their manufacture (3.7 percent of total exports), motor vehicles (1.7 percent of exports), and iron and steel (1.5 percent) are associated with high emission levels (for example, more than 5 times the average level of the United States, Germany, and Spain in the case of plastics and their manufactures) with a moderate level of vulnerability. On the other hand, cut flowers (3.8 percent of total exports) and bananas (2.9 percent) are associated with a greenhouse gas emission intensity above international reference values and with high levels of vulnerability (Eurostat, 2022; National Inventory Report, 2022).

22 The choice of these countries is not arbitrary, as they are likely to be considered as benchmarks for assessing the GHG emissions intensity of trade flows.

23 Three characteristics of export destination countries are used to determine this risk: income level, climate ambition, and demonstrated willingness to consider climate-related trade measures. Equal weight is given to each characteristic. For each sector, the final score is assigned by weighing according to trade with the top five export destination countries (see the Annex for the detail of the calculation) (Cosbey & Vogt-Schilb, 2023).

24 The EU's adoption of the Border Carbon Adjustment Mechanism presents relatively few risks in principle for the three countries analyzed, as it focuses on upstream products of heavy industry. Steel exports from Colombia would be the most exposed, although these are mostly destined for markets that are not expected to implement climate-related trade measures in the short term.

Figure 2.1. Vulnerability of Colombia's exports to climate-related trade restrictions



Source: Cosbey and Vogt-Schilb (2023) based on Eurostat data (2022), national data (Colombia's input-output matrix, 2017), and the National Inventory Report (2022). The size of the bubbles reflects the value of exports in 2022.

It is important to note that this analysis, while considering the emission levels of each country's exports, does not address their potential for reduction. Additionally, a limitation of this analysis is that while it takes into account the adoption of trade restrictions by destination countries, it does not consider the progress and mitigation instruments implemented by the origin countries. For example, effective carbon rates (ECRs)[25] have been recently estimated for CO_2 emissions from energy use for 18 LAC countries (Ahumada *et al.*, 2023). The results indicate that ECRs were low in LAC countries, with the price of carbon emissions from energy use being 58 percent of that in OECD countries. When energy subsidies are factored in, the average ECR in LAC drops to 41 percent of that in OECD countries. For these reasons, the presented results should not be interpreted as an exercise in identifying this country's decarbonization opportunities, which will be discussed further in the second section.

25 This is the total price applied to CO_2 emissions from energy use as a result of market-based instruments. These mechanisms are considered a crucial policy for mitigating climate change, because they increase the price of carbon-based energy and create incentives to reduce CO_2 emissions.

Ecuador

When the foreign value added incorporated in Ecuadorian exports is analyzed, a deterioration is observed over the last three decades. Furthermore, at the end of this period foreign value in Ecuador added was below the regional average, being 9 percent between 2017 and 2019 in Ecuador, compared to the average of 10.1 percent across the Andean Region (Table 2.2).

In environmental terms, in 2019 the country generated a total of 72,529 kt of CO_2 eq (0.2 percent of total global GHG emissions for that year according to World Bank data).[26] The country's energy demand largely comes from fossil fuel sources such as diesel or gasoline (83 percent), which are among the most polluting (Ministry of Energy and Mines, 2022). It is estimated that 47 percent of the country's GHG emissions are produced by this sector. Additionally, of the 4.1 million tons of solid waste generated per year, only 6 percent is recycled (Baque *et al.*, 2020).

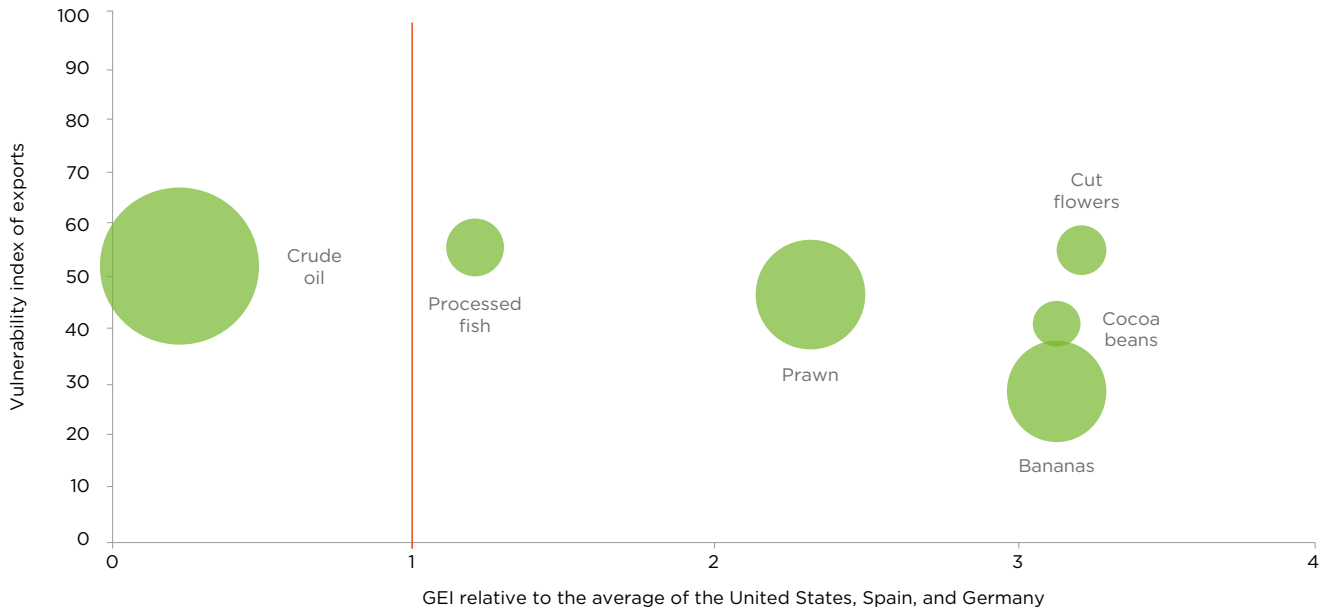
In response to this issue, the country has set a goal of reducing GHG emissions by 20.9 percent for the period 2020–2025.[27] To make progress toward this objective without neglecting the international integration agenda, it is imperative to take measures to promote the decarbonization of the export portfolio.

26 https://datos.bancomundial.org/indicador/EN.ATM.CO2E.PC?view=chart.

27 https://www.undp.org/es/ecuador/news/ecuador-reducir%C3%A1-sus-emisiones-de-gases-de-efecto-invernadero-hasta-2025.

Graph 2.2 presents the results of the vulnerability analysis of Ecuador's exports in terms of climate-related trade restrictions. As shown, there are multiple sets of highly relevant products in the export basket with high levels of risk. Shrimp (19 percent of total exports), bananas (15.6 percent of exports), cocoa beans (3.4 percent), and cut flowers (4 percent) are associated with high emission levels combined with high vulnerability levels in terms of export destinations. For example, among the top five destinations for shrimp exports, several countries have shown themselves willing to implement environmental-related trade restrictions, including the United States, Spain, and France. Processed fish products (5.4 percent of exports) are also associated with a high vulnerability index.

Graph 2.2. Vulnerability of Ecuador's exports to climate-related trade restrictions



Source: Cosbey and Vogt-Schilb (2023) based on Ecuador's biennial update report (Ministry of Environment, 2016) and greenhouse gas emission data from 2018. The size of the bubbles reflects the value of exports in 2022.

Peru

The incorporation of foreign value added in Peruvian goods exports has shown a growing trend in recent years, surpassing the average of the Andean Region (12.1 vs. 10.1 percent). However, the level of integration of foreign inputs in Peruvian exports is still well below the average for Latin America and other regions such as Asia and the European Union (Table 2.2).

GHG emissions in 2019 amounted to 100,730 kt of CO_2 equivalent (0.2 percent of total global emissions).[28] This represents an 18.4 percent increase compared to the level of emissions in 2010. Despite its limited contribution to global GHG emissions, the country ranks as the third-most vulnerable in the world to climate risks. Over the past 30 years, Peru has lost 22 percent of the surface area of its glaciers, which account for 71 percent of the world's tropical glaciers.[29] According to official sources, by the year 2014 64 percent of all emergencies nationwide were related to climatic events such as droughts, rains, floods, and frosts (Ministry of Environment, 2016).

The country has committed to reducing its GHG emissions by 30 percent by 2030, compared to its 2010 emissions.[30] Similar to Ecuador, Peru needs to implement immediate measures to meet this commitment and advance its international integration agenda.

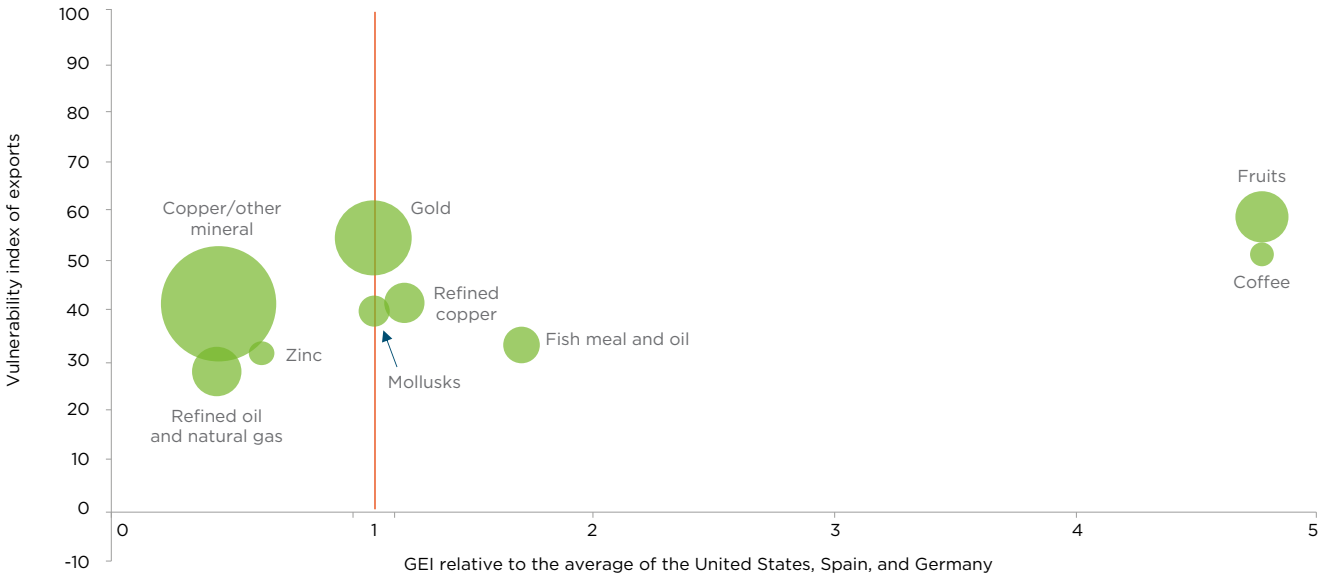
As shown in Graph 2.3, exports linked to agribusiness and food present high levels of risk in terms of climate-related trade restrictions. Products such as fruits (7.4 percent of total exports), fishmeal and fish oil (3.8 percent of exports), and coffee (1.7 percent) stand out. For instance, the top five export destinations for Peruvian coffee are the United States, Germany, Belgium, Sweden, and Canada. Although there is a lower sense of urgency with regard to other product categories, they do require attention as well. Export flows related to gold (15.6 percent of total exports), refined copper (4.5 percent), and mollusks (2.6 percent) show emission intensity above the international reference combined with moderate to high levels of vulnerability in terms of export destinations.

28 According to World Bank data: https://datos.bancomundial.org/indicador/EN.ATM.CO2E.PC?view=chart.

29 https://www.bancomundial.org/es/news/feature/2013/03/25/peru-prepares-to-face-the-retreat-of-andean-glaciers

30 https://news.un.org/es/story/2015/09/1340431.

Figure 2.3. Vulnerability of Peru's exports to climate-related trade restrictions



Source: Cosbey and Vogt-Schilb (2023) based on data from the National Institute of Statistics and Informatics (2021) and the Peru 2021 National Inventory Report (Ministry of Environment, 2021). The size of the bubbles reflects the value of exports in 2022.

2.1 Scope of the research

As mentioned above, this study focuses on Colombia, Ecuador, and Peru. Regarding destination markets of trade flows, special attention is given to regional trade, considering all the LAC countries and the United States, which together represent the primary destinations for exports from the three countries under study.

The focus on these target markets serves two purposes. First, it facilitates the identification of opportunities to strengthen regional value chains, which is of particular interest given the objective of this study. Second, the choice of target markets enables the highlighting of opportunities related to the shortening of value chains, which are particularly relevant in the current context.

To gain a deeper understanding, four specific chains—fisheries, textiles and apparel, plastics and rubber, and automotive—were studied in detail for all four countries, except for the automotive chain in Peru, because its level of development is still in the early stages. These chains were selected based on dialogue with and interest from local authorities, as well as their decarbonization potential, and furthermore they belong to sectors that are significant sources of exports in one of the three countries (for example, the fisheries sector contributes22 percent of Ecuador's exports). Additionally, the decision was made to focus on sectors for which more information was availableand a relevant productive structure. It is expected that the decarbonization agenda and the potential for industrial and production process modernization in these chains will serve as a demonstration effect to extend the analysis to other relevant sectors in these and other countries in the LAC region.

In 2022, exports from these sectors reached US$14 billion, accounting for 10 percent of the total value of exports from these three Andean Region countries. Additionally, they are characterized as a significant source of emissions. Globally, the textiles sector, for example, emits approximately 1,200 million t CO_2

eq, which is more than the aviation and maritime transport industries combined (Ellen MacArthur Foundation, 2017). The plastics industry, in turn, is estimated to account for 4 percent of total global emissions (CIEL, 2019). These four sectors will play a crucial role in advancing the sustainable integration of the region, and despite their high contribution to the carbon footprint, they present numerous decarbonization opportunities, as will be explored in the third chapter.

It is worth noting that when we discuss decarbonization opportunities, we consider production processes and the manufacturing of goods associated with a reduction in the carbon footprint. While biodiversity constitutes a fundamental aspect of the current sustainability debate, addressing the discussion on this topic is beyond the scope of this report.[31]

During the period 2017-2019, the average Latin American country showed exports that contained 18.1% of foreign value added, compared to 33.1% in the average Asian country and 43.3% in the average European Union country.

2.2 Methodology

The identification of opportunities for integration into GVCs and decarbonization combines two types of analyses. First, a top-down or intensive exercise in data analysis and processing focuses the study and enables the development of preliminary hypotheses on where the main opportunities for integration into GVCs are located. This exercise relies on the analysis and processing of trade flow statistics and emission intensity, global and country-level databases on international competitiveness, and sector reports prepared by relevant national associations or international institutes.[32]

This approach is complemented[33] with a bottom-up, intensive 'fieldwork' exercise that validates and refines the findings through a 'micro' perspective that captures information not contained in traditional statistics and serving as a key input for the identification of opportunities and obstacles. The bottom-up analysis begins with semistructured interviews with key stakeholders, including business leaders, business associations, experts, and government officials. This information is then contextualized by a review of the specialized literature and validated with publicly available statistics[34] as well as input from additional experts.

31 For example, in Colombia the fishing sector faces numerous challenges in this regard. The increase in demand for fishery products has been accompanied by fishing practices that threaten biodiversity (Garzón *et al.*, 2016).

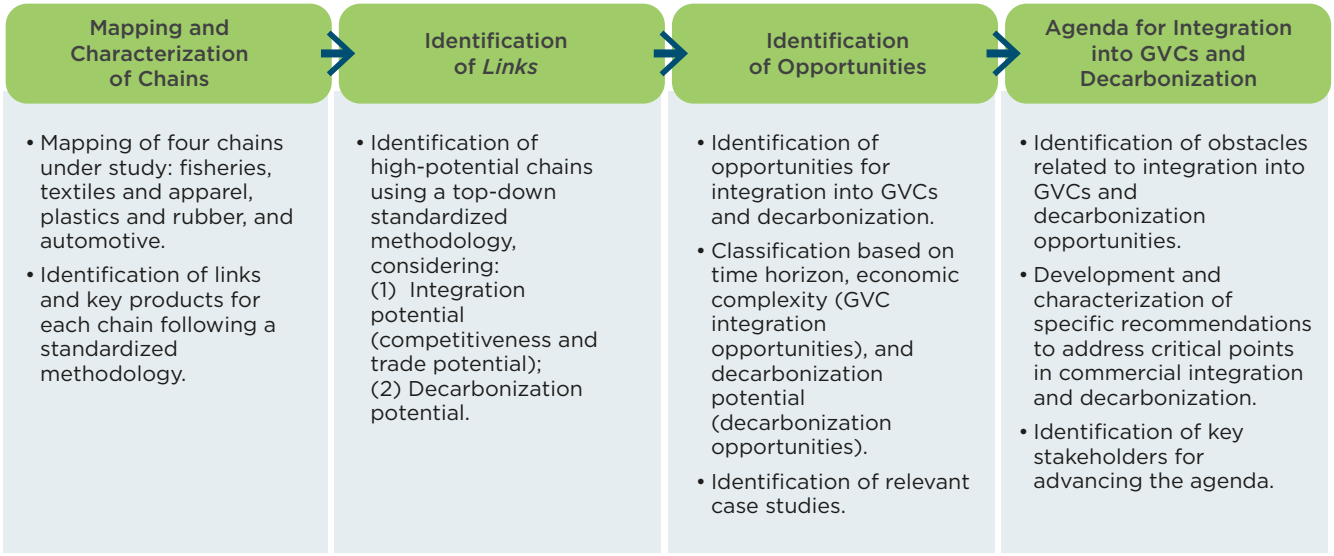
32 These are explained in detail in the Annex and are reflected comprehensively in the bibliography.

33 This interaction between the two levels is carried out iteratively, as described in the Annex.

34 For example, by corroborating the potential of a specific product through the analysis of trade flow data and evaluating the value proposition in terms of competitive advantages and disadvantages found in the exercise of identifying high-potential links.

Figure 2.1 presents the details of the analysis carried out for the three countries and four chains.

Figure 2.1. Methodological approach



Source: Prepared by the authors.

Mapping and Characterization of Chains

First, a mapping and characterization were conducted for the four chains included in the study: fisheries, textiles and apparel, plastics and rubber, and automotive. For each of these chains, a sequence of links was identified, grouping the main activities that occur throughout the production and commercialization process of the studied goods.[35] Additionally, specific products corresponding to each link within the chains were identified.

In defining each link, business processes resulting in a product transformation were grouped and a list of the most representative products arising from that link was compiled.[36] Finally, links with the highest potential for emissions reduction (for example, through efficient resource use and material reuse) that can be part of these chains, even in an incipient manner, were identified.[37]

This resulted in each mapped chain's also including links that have recently emerged due to new trends in environmental sustainability. The chain mapping is common to all three analyzed countries;[38] hence it is performed once for the region.

35 For this study, a mapping method was used based on establishing a simplified structure—known in the literature as a simplified conceptual map—for each chain (DNP, 2004).

36 This process was based on the exercise carried out for Colombia by the Departamento Nacional de Planeación using the input-output matrices of that country. Subsequently, these chain maps were reviewed in light of the cases of Ecuador and Peru to obtain a mapping that was relevant throughout the region.

37 See, for example, Fazekas *et al.* (2022).

38 With the exception of the automotive chain in the case of Peru, which is not considered part of the study.

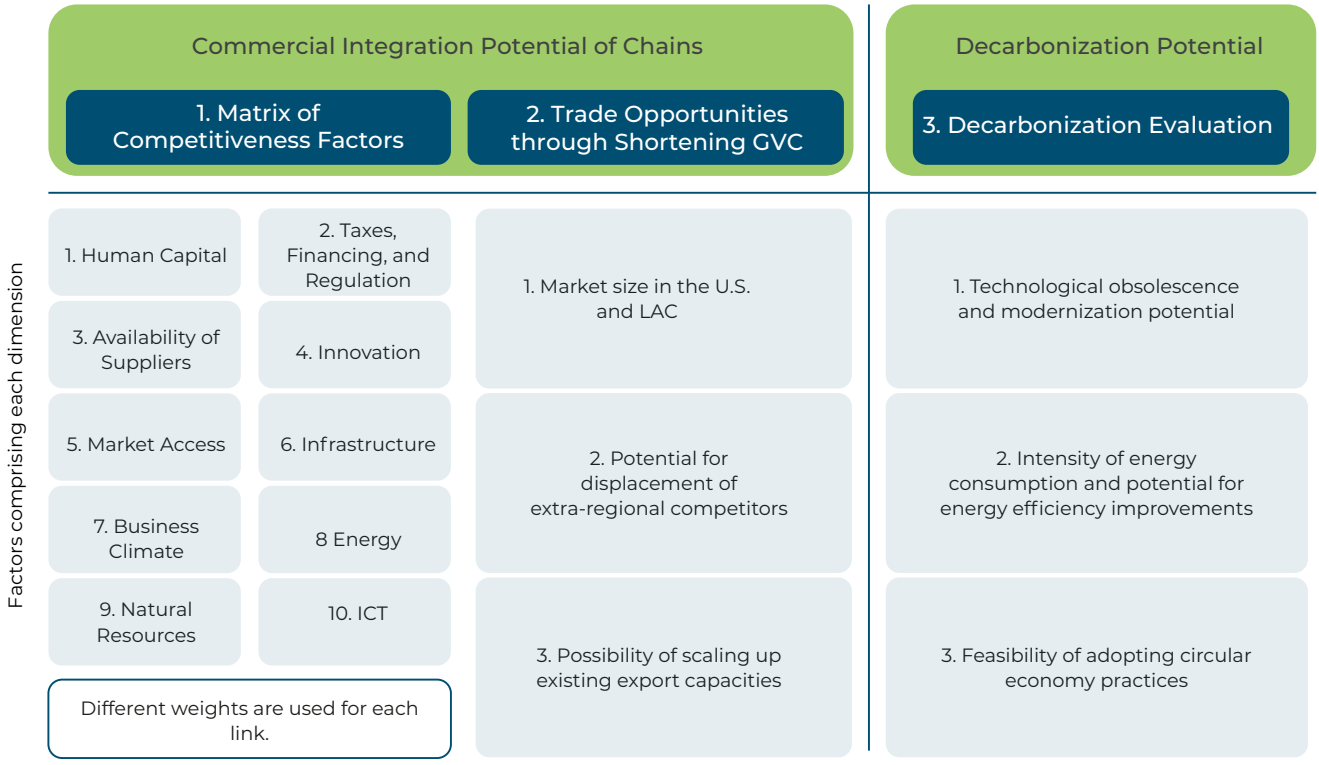
Identification of High-Potential Links

Once the links for each of the four chains have been mapped, the next step involves identifying those links with the greatest potential for strengthening integration into GVCs and decarbonization in each country.

It is important to note that the set of links identified as having high potential does not aim to be a 'selection of winners,' but seeks to formulate initial hypotheses about those links where each country has greater opportunities to attract investments and generate exports associated with sustainable GVC integration. This enables the focusing of the fieldwork on the identified links, with the conclusions of the analysis subsequently validated in the bottom-up analysis.

The assessment of the potential for each link considers two main dimensions: the potential for integration into GVCs and for decarbonization. The former is further divided into two subdimensions: the global competitiveness level of the links and trade potential, reflecting primarily the potential to increase exports. Figure 2.2 provides details on the variables considered for measuring each of these dimensions and subdimensions.

Figure 2.2. Dimensions for assessing the potential of the links in the value chains studied



Source: Prepared by the authors.

The competitiveness level is calculated by combining the evaluation of 10 factors that assess the global competitiveness of each sector with a matrix of weights that assigns a specific weight according to the relevance of each factor for each considered link (see Annex).

The trade potential is calculated first by identifying the relevant market size in terms of imports from the target markets[39]—the United States and LAC—attached to the link. Then, the potential for shortening supply chains behind each link is captured,[40] as well as the drive for diversifying the export portfolio through the development of new capabilities (see details in the Annex).[41]

Finally, the dimension of decarbonization potential is measured based on the qualitative assessment of interviewed entrepreneurs and the evaluation of technical experts specializing in decarbonization.[42] The assessment and evaluation reflect the decarbonization potential of each link based on three elements: (1) the degree of technological obsolescence of the link and the potential for industrial and production process modernization,[43] (2) the energy consumption intensity and the potential for adopting techniques that result in higher energy efficiency, and (3) the feasibility of adopting practices of material reuse and a circular economy. This dual view of the potential of the links significantly enriches a 'one-dimensional' perspective that only considers the potential for integration into GVCs. In particular, incorporating CO_2 emission effects enables:

The low levels of foreign direct investment (FDI) received by the region, while recovering after the COVID-19 pandemic, have not been able to surpass the levels previously recorded.

- The strengthening of the effort to promote the sustainable development of links that have dual potential to achieve both greater export and investment impetus and emission reduction.
- The including of links that may not have been explored in depth when only potential integration into GVCs was considered, but that are 'sufficiently close' to being competitive and have high decarbonization potential.
- The thinking about the need for mitigation strategies to promote the sustainability of some links that, while having high levels of potential integration into GVCs, have low levels of decarbonization potential and a high carbon footprint.

39 It is beyond the scope of this report to analyze trade flows toward extraregional markets such as, for example, the European Union.

40 This identifies which of these products the United States imports from countries in other regions.

41 This involves identifying, within the range of these products, which ones Peru, Colombia, or Ecuador export in significant amounts to the United States.

42 The details are presented in the Annex.

43 This is because typically older machinery and equipment are associated with lower levels of energy efficiency.

Identification of Opportunities for Integration Into Gvcs and for Decarbonization

Once high-potential links have been identified, a more in-depth exploration of opportunities is carried out through targeted fieldwork. The identified opportunities consider both trade integration and decarbonization possibilities.[44]

Opportunities for integration into GVCs include specific products (e.g., tilapia fillets) with high potential to increase exports and attract investment, taking into consideration the scope of the study and the fact that they are associated with strengthening GVCs.

Decarbonization opportunities, on the other hand, refer to changes and transformations throughout the production and commercialization process (e.g., electrification of transportation) and the development and incorporation of new products (both inputs and final goods) that can realize a reduction in the carbon footprint of the analyzed sectors and products.

While it is implied in the definition, it is important to note that not necessarily every decarbonization opportunity is accompanied by an opportunity to strengthen integration into GVCs (and vice versa). Furthermore, decarbonization opportunities linked to production or commercialization activities that do not take place locally are excluded from the analysis. In cases where opportunities for integration into GVCs align with decarbonization opportunities, we refer to these as dual opportunities for promoting sustainable trade in the region.

Once the opportunities are identified through fieldwork, they are classified based on their time horizon. The assessment of the relevant time horizon for each opportunity results from information provided by the entrepreneurs who were interviewed related to the economic and technical feasibility of taking advantage of the opportunities, complemented by the evaluation of sectoral experts.

The final classification of relevant time horizons[45] for opportunities for integration into GVCs is as follows:

› **Short term.** These are opportunities that

(1) are associated with goods or services already exported to the United States and/or countries in LAC, where the required capabilities already exist; however, increasing exports may require specific interventions (e.g., customs process improvement, expansion of talent pool); and/or

(2) are associated with goods or services either not exported on a large scale to target markets (these goods/services may be being exported to other markets) or are very close to production and where most capabilities already exist, but efforts and/or investments are needed to expand capacity and develop access to new markets (e.g., regulatory redesign).

44 In addition to identifying opportunities for integration and decarbonization, the fieldwork helped identify specific projects undertaken by companies (both those already established in the country and those without a direct presence at the moment) associated with these opportunities. Some of these projects are also analyzed and presented as case studies. These projects involve new investments by multinational or local companies, as well as others that present the opportunity for companies already established in the country to become suppliers within the value chains governed by foreign firms.

45 In addition to being classified according to the time horizon, each producted is evaluated in terms of the associated level of economic complexity following Hausmann *et al.* (2011), that is, in terms of the level of sophistication and the capabilities required to produce these goods, in order to gain a perspective on the contribution to value-added and the diversification of exports for each opportunity.

› **Medium term.** These are opportunities that

(1) are associated with goods or services that are not produced (at least in significant quantities) or exported, but are 'adjacent' or quite close to the current production portfolio, as per Hausmann *et al.* (2011); and/or
(2) require significant investments (e.g., infrastructure) and the development of new capabilities.

It is important to highlight that, in the case of decarbonization opportunities, the time horizon for their realization is different (typically longer) than that considered for integration into GVC opportunities. This is because many of the transformations required to promote decarbonization opportunities (e.g., those related to cultural changes, transformations of production processes associated with large investments, creation of new products and markets) entail addressing challenges that are more structural in nature and as such involve a longer time frame. For this reason, the following time horizons are considered for classification:

› **Intermediate term.** These transformations are currently being implemented globally as well as locally or are still incipient within the region.

› **Long term:** These transformations have demonstrated potential in global markets; however, enablers are needed that require structural changes in the region.

› **Prospective.** While there is technical potential, these transformations have yet to be implemented or are still globally incipient. Additionally, there is no conclusive evidence regarding the cost benefit of their implementation.

Agenda for integration into GVCs and for decarbonization

Finally, the main obstacles to taking advantage of the opportunities for strengthening integration into GVCs and decarbonization are discussed. The obstacles are identified based on the information collected in the fieldwork, which is complemented by studies and information available for each country, and are classified as either cross-cutting and sector-specific. In addition, the required time horizons to address them are identified. In particular, a distinction is made between short- and medium-term obstacles (can be addressed within a horizon of less than five years) and structural or long-term obstacles (require a horizon longer than five years).

Likewise, within the universe of identified obstacles, those crucial to advancing the sustainable trade agenda are prioritized. We refer to these obstacles as "critical points." The details of each of these can be found in the Annex.

For these obstacles, a set of priority policy proposals is presented to strengthen regional productive integration and move toward carbon neutrality in each country.

3

STRATEGIES

3. STRATEGIES TO BOOST PRODUCTIVE INTEGRATION AND DECARBONIZATION

3.1 Mapping and characterization of value chains

A global value chain (GVC) is defined as a process in which a group of companies in different countries collaborate—in areas from design to product distribution—under the coordination of a lead company with the aim of minimizing the total costs of the system (Blyde *et al.*, 2014). The lead company may own the firms producing these inputs or may work with independent suppliers. The different parts that make up a GVC tend to work cohesively so that the various inputs required are produced to the appropriate specifications and distributed efficiently throughout the chain. It is estimated that international trade channeled through GVCs currently represents around 50 percent of total trade, a 42 percent increase compared to the early 1990s (World Bank, 2020).

The significant growth in organized production through GVCs has made entry into them a condition for survival in export markets and progress in terms of productivity, technology, and quality, thanks to the dissemination of knowledge and information that often occurs among the links in a GVC (Garcia *et al.*, 2021).

Countries in the region have begun to pay special attention to how their economies integrate into GVCs and regional value chains (RVC), because participation in them brings various benefits. In addition to the traditional development benefits provided by trade and investment, participating in a chain contributes to increased productivity, diversification of trade and production, greater transfer of knowledge and technology at the local level, and the generation of more and better jobs that support gender equity (World Bank, 2020).

GVCs and RVCs have the potential to increase the productivity of countries not only because they bring about specialization in sectors where they have comparative advantages, but also because they provide the opportunity for specialization in certain stages of the production of a good that firms in particular countries can do relatively better, generating additional gains from trade. This is especially relevant for relatively smaller countries, where specializing in the complete production of a final good is often complex.

Technology transfer and knowledge dissemination from global lead companies to different links in the chain constitute another channel associated with increased efficiency and productivity. For example, interacting with global companies within a GVC enables suppliers to improve their production processes, achieve higher quality levels, and increase their response speeds (Humphrey & Schmitz, 2000). Firms in emerging countries can benefit from greater access to organizational, product, and process innovations. There are examples of successful cases of knowledge dissemination and learning within GVCs in diverse sectors such as agribusiness (Cafaggi *et al.*, 2012), apparel (Gereffi, 1999), motorcycles (Fujita, 2011), and information technology (Kawakami, 2011). Recent studies, for example, demonstrate that a 10 percent increase in a country's participation in GVCs leads to an increase of 1.6 percent in average labor productivity and between 11 and 14 percent in per capita GDP (Constantinescu *et al.*, 2019).

Participation in GVCs also has an impact in terms of employment. While production tends to be more capital intensive, increased exports lead to the creation of more jobs. Participation in GVCs tends to increase the demand for skilled labor and eventually the skills of the labor force. For example, Shepherd and Stone (2012) found that in a sample of developing countries, firms participating in GVCs demand more-skilled personnel and pay higher wages than export-only and nontrading firms. In turn, World Bank (2020) shows that firms participating in GVCs tend to employ more women and also improve social outcomes.

Finally, entry into GVCs and RVCs can lead, under certain conditions, to an upgrading of the type of activities developed in the local economy, resulting in a larger proportion of activities' being those where higher value added is generated (Antràs, 2020). Thus, participation in GVCs and RVCs can contribute to growth acceleration in emerging countries, something that has already been observed in recent decades for several East Asian nations.

On the basis of the field analysis conducted through 44 company interviews and government entities, a total of 23 opportunities for insertion were identified along the four chains analyzed.

In light of the potential benefits derived from participation in GVCs and RVCs, this study focuses on four chains with high potential to boost GVC integration and decarbonization in the Andean Region. In taking a more-detailed and in-depth look at these sectors, a mapping of the main links that compose these four production chains was developed.

These links group together the main activities that characterize the integrated process of the production, transformation, and marketing of the goods analyzed. This approach at the level of production links provides a more precise characterization in terms of competitiveness, integration potential, and decarbonization potential than do traditional approaches based on aggregate figures for sectors or disaggregated at the firm level.

As a result, 24 mapped links were specified along the four chains and for each link a set of products[46] that make up the productive structure of the link was identified. The following is a brief description of each of the production chains studied in this study.

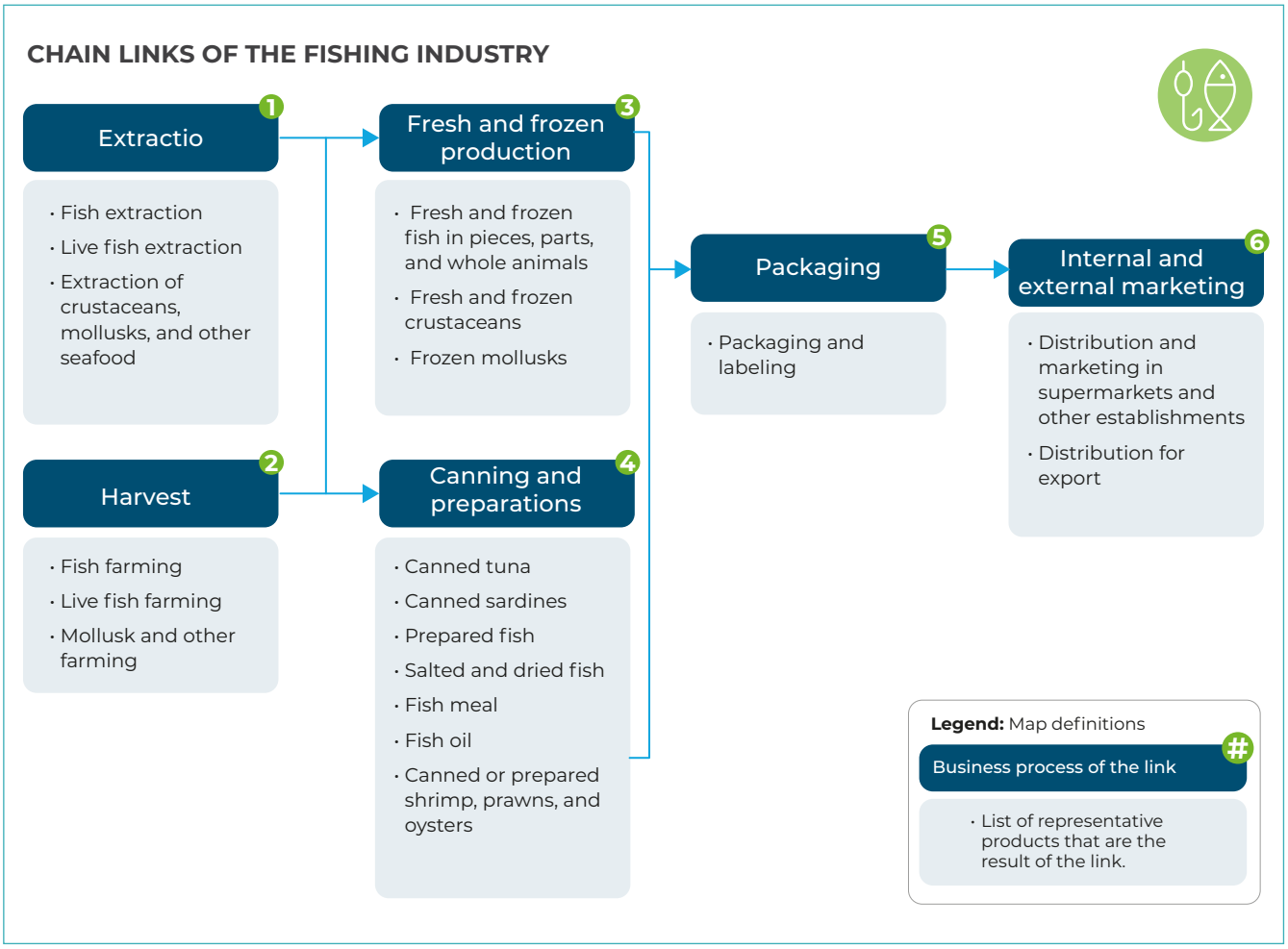
46 Specified by the international trade classification under the name of subheadings of the six-digit tariff code (HS code).

Fishing

The conceptual map of the fishing chain is shown in Figure 3.1, which identifies six links, based on the extraction of fish, crustaceans, and mollusks at sea and the harvesting of species in aquaculture. Both activities lead to the production of fresh and frozen products as well as preserves and preparations, links that are typically vertically integrated in the Andean Region. The next link downstream is the packaging and labeling of fishery-generated products, which is followed by the domestic and foreign marketing link.

All the links have a relevant presence in the countries studied, but differ in their intensity: extractive fishing with large fishing fleets tends to be the strongest in Ecuador and Peru, particularly for consolidated products such as tuna, billfish, and shrimp and prawns; and aquaculture is an incipient activity in the case of Colombia for products grown in pools such as trout or tilapia.

Figure 3.1. Conceptual map of the fishing value chain



Source: Prepared by the authors based on DNP (2004), interviews with government entities, interviews with associations and chambers of commerce, and expert opinions.

Textiles and apparel

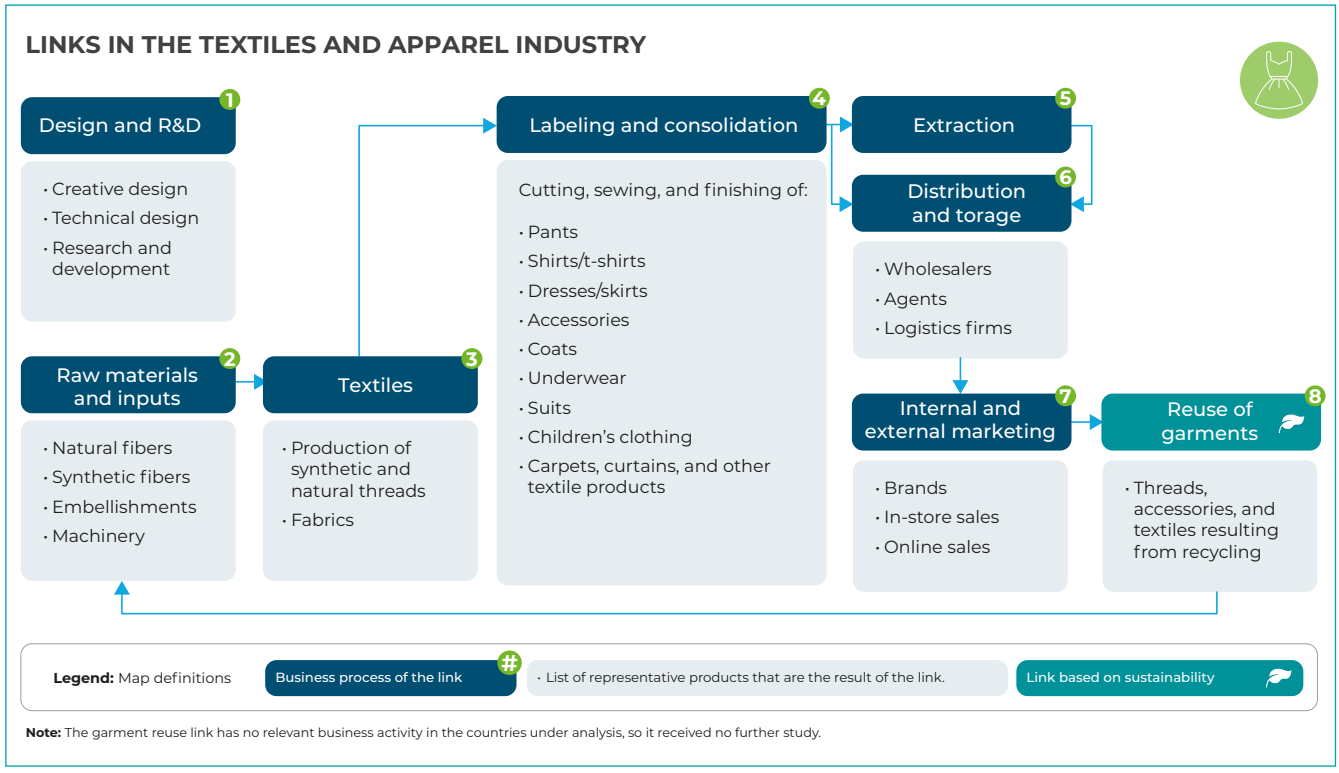
The conceptual map for the textiles and apparel chain is shown in Figure 3.2 There are eight links in this chain, of which only seven are discussed in this study, because the garment reuse link is only incipient in the countries of the Andean Region.

The textiles and apparel chain has a horizontal design and R&D link, where the creative and technical design of materials and garments takes place. The chain then flows from raw materials and inputs—both natural and synthetic fibers and blends—to the manufacture of yarns, fabrics, and textiles in the textile link. This is followed by the central link in the chain, that of apparel production, where a wide variety of products are manufactured, with an accelerated trend toward short-cycle fashions.

Finally, some economies have formed a separate apparel labeling and consolidation link to achieve greater efficiency in logistics and foreign trade processes, which then feeds into distribution and warehousing as well as domestic and foreign marketing, which is typically performed by the brands that govern the chain, either through in-store sales or e-commerce channels.

Notwithstanding the contraction trends of the textile industry in LAC in recent decades, the countries in the study are present in the textile and garment production links especially, with an outstanding example being the high-quality cotton-based knitted fabrics produced in Peru for the sale of U.S. and European brands.

Figure 3.2. Conceptual map of the textiles and apparel value chain



Note: The garment reuse link has no relevant business activity in the countries under analysis, so it received no further study.

Source: Prepared by the authors based on DNP (2004), Fernández-Stark *et al.* (2022), interviews with government entities, interviews with associations and chambers of commerce, and expert criteria.

Plastics and rubber

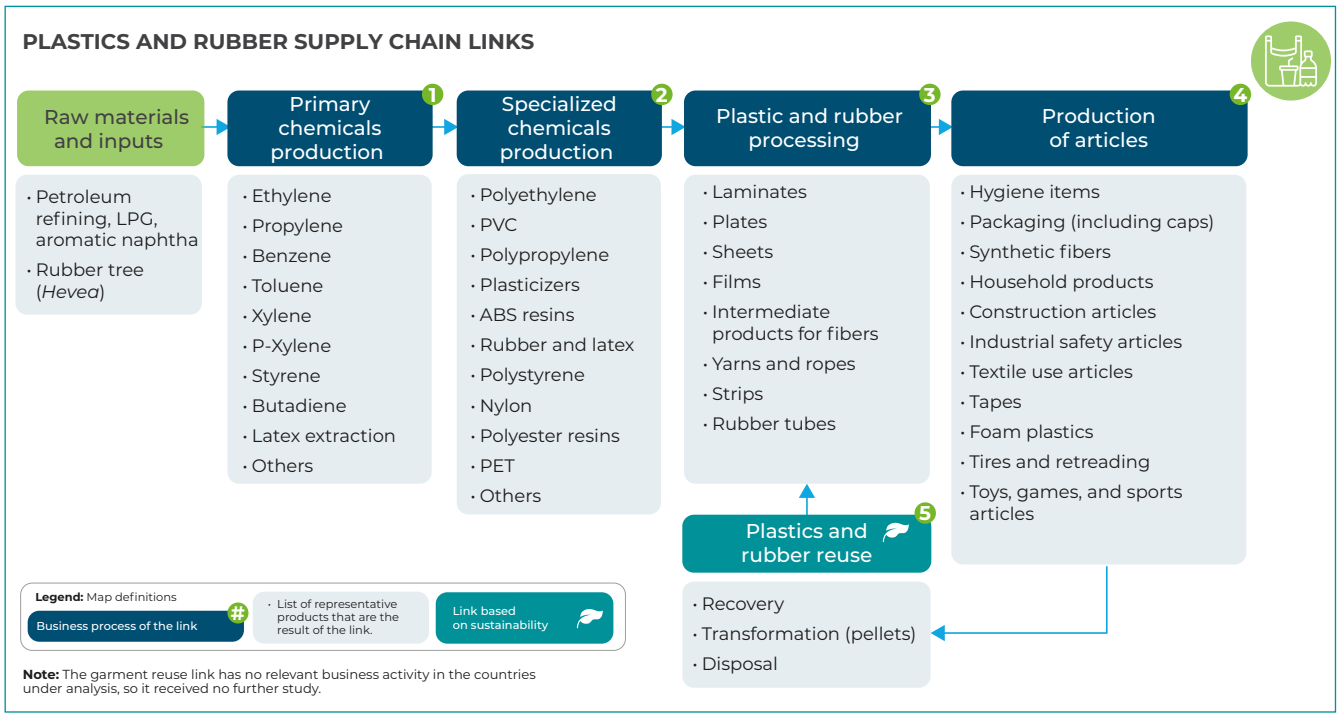
The conceptual map for the plastics and rubber chain is shown in Figure 3.3. There is a high level of dispersion in the downstream links of this sector due to the enormous diversity of articles produced with plastics or rubber, which feed a large number of industries and sectors.

That said, a conceptual and simplified view of the chain starts with a raw material and input link associated with the oil and gas sector, in the case of plastics, or agriculture, in the case of the rubber tree. Based on this primary link, five links in the chain are mapped.

Initially, there is the link for the production of primary chemicals such as ethylene oxide, propylene, and other gases that are by-products of oil refining.[47] Next, the specialized chemical production link brings together transformation processes of these basic substances, such as the polymerization of propylene, which results in the production of polypropylenes and other plastics and specialized resins. The plastics and rubber transformation link that follows aggregates the various techniques of preparation and transformation of polymers, resins, latex, etc., into forms conducive to the manufacture of articles, such as sheets, plates, films, yarns, among many others. Finally, the article production link refers to items manufactured from plastic or rubber and the reuse link is based on the recovery and disposal of materials to be recycled.

The plastics and rubber chain is strongly present in the three countries due to different factors, such as the large oil and gas refining capacity in Colombia and the development of industries for the production of articles for construction, cosmetics, and pharmaceuticals in Colombia, Ecuador, and Peru.

Figure 3.3. Conceptual map of the plastics and rubber value chain



Source: Prepared by the authors based on DNP (2004), interviews with government entities, interviews with associations and chambers of commerce, and expert opinions.

47 For simplicity and consistency with the rest of the chains analyzed, activities "upstream" of this step, such as, for example, oil refining or rubber cultivation, are not considered part of this chain.

Automotive

Figure 3.4 describes the conceptual map for the automotive chain. In this chain, seven links are identified, of which six are considered in what follows, because the link of resale and reuse of materials (such as aluminum and glass) is incipient in the countries of the Andean Region.

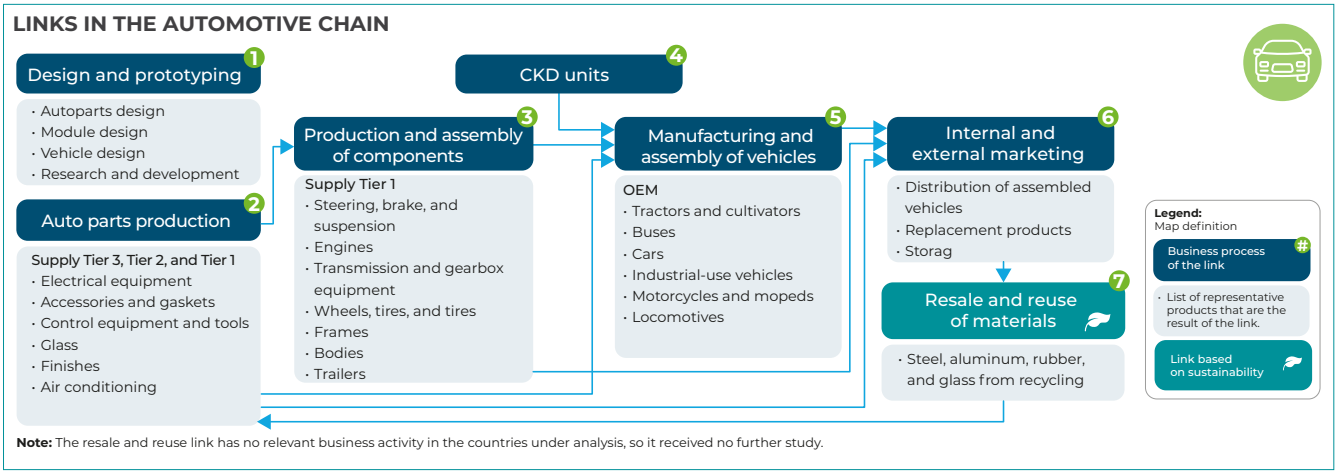
Similar to the textile sector, the automotive chain has a horizontal link for design and prototyping, which brings together activities related to vehicle design, brands, materials, and research and development. Subsequently, the chain is formed in levels according to its complexity and integration, starting with the autoparts link, where equipment, parts, finishes, and raw materials are manufactured, typically involving Tier 3, Tier 2, and Tier 1 suppliers.[48]

Next, in the link of production and assembly of components, the manufacturing of systems, subsystems, and components such as engines, steering systems, and transmissions occurs, specifically involving higher-complexity and quality Tier 1 suppliers. In some countries, there is a link for the production of complete knock-down (CKD) units, which are kits of completely disassembled parts and components that can be assembled at the destination plant.

Then, the link for the manufacturing and assembly of vehicles follows, which involves original equipment manufacturers (OEMs), that is, companies with assembly plants owned by the brands that govern the chain. This link results in passenger and cargo transport vehicles and motorcycles, for example.

The automotive sector in the countries studied had relatively strong vertical integration in the 1990s, with assembly of European and American brands for domestic sales and export quotas to the region. However, in the last 20 years there has been a contraction and relocation of downstream activities, to the point that for example Peru no longer has local OEMs and supplies its market with vehicles imported from Asia, the United States, Mexico, and other European and LAC countries.

Figura 3.4. Mapa conceptual de la cadena automotriz



Source: Prepared by the authors based on DNP (2004), interviews with government entities, interviews with associations and chambers of commerce, and expert opinions.

48 The term "tier" is commonly used in the automotive industry to refer to the level of suppliers according to their degree of complexity and their relationship between manufacturer and supplier. Thus, Tier 1 suppliers supply components directly to the OEMs and have certified quality standards aligned with the needs of the brands that govern the sector, while Tier 3 suppliers supply raw materials of lower complexity.

3.2 Strategy for sustainable value chains in Colombia

3.2.1 Identification of links with high potential

As explained in the methodology, the first step in the construction of the productive GVC integration and decarbonization strategy is to identify links with high potential in terms of integration and decarbonization. This analysis enabled us to focus the necessary fieldwork to identify opportunities for and obstacles to the promotion of sustainable integration.

If integration potential alone is considered, in the case of Colombia, the results show that the links with the greatest potential are Harvesting in the fishing chain; Design and R&D, Textiles, and Garment production in the textiles and apparel chain; Plastic and rubber transformation, Specialty chemical production, and Article production in the plastics and rubber chain; and finally, Component production and assembly and Vehicle manufacturing and assembly in the automotive chain. Regarding the fishing and textile chains, these links stand out mainly because of their comparative advantages in competitiveness factors such as innovation and financing. In the case of the plastics chain, human capital and availability of suppliers are more important than other factors (see the Annex for more details).

As explained above, the perspective of productive integration is complemented by a view to the reduction of emissions, which considers both economic and technical feasibility.[49] Graph 3.1 shows the potential of each link analyzed, considering the dual vision that includes the potentials for GVC integration and for decarbonization.[50]

From the intersection of these dimensions, different sets of links emerge that have different policy implications. First, at the top right is a set of links with the dual potential to increase exports and reduce CO_2 emissions through chain-shortening initiatives (blue area of the graph). In this category fall Plastics and rubber processing, Garment production, Textiles and fabrics, and Fishing by harvesting fall into this category.

This set of high potential links is extended to incorporate links that, despite having less integration potential, have a high decarbonization capacity (green area of Graph 3.1). In the particular case of Colombia, these links are Production of fresh and frozen fish in the fishing chain, Distribution and storage of clothing in the textiles and apparel chain, and Design and prototyping of vehicles in the automotive chain. These two blocks were the main focus of the fieldwork and are where the vast majority of opportunities are concentrated.

In the lower left quadrant are links with low potential for both GVC integration and decarbonization. These links require strategies to limit exposure to them[51] or to address structural factors (outside the time horizon considered in the study) to generate a significant change in their potential in terms of sustainable GVC integration.

Finally, it is important to consider a group that, while having a high potential for GVC integration, does not have a high decarbonization potential, although it does have a high initial carbon footprint (indicated in the gray box in Graph 3.1). These links are Production of specialized chemicals in the plastics and rubber

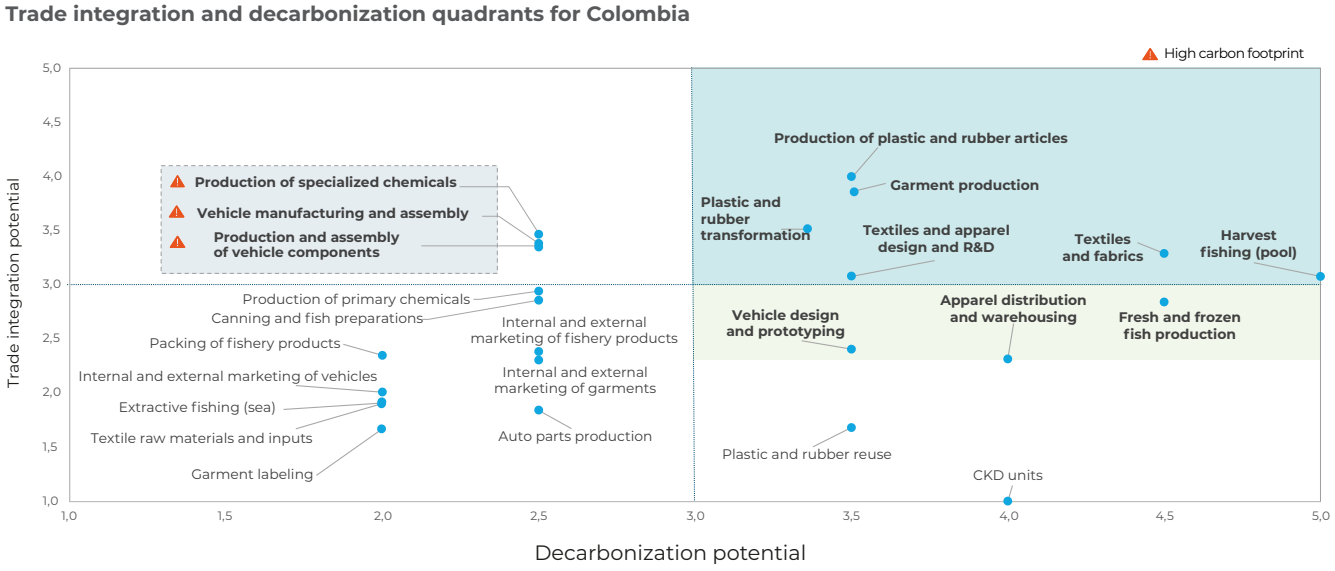
49 Decarbonization potential per link was measured by combining qualitative assessments of the entrepreneurs interviewed during the fieldwork with expert assessments. The results presented here are not intended to be an accurate measurement of the potential reduction of the carbon footprint of each link, but rather a first approximation to identify different possible levels of decarbonization that should be examined in greater detail at a later date.

50 For a detailed analysis of how each dimension is calculated, please see the Annex.

51 Only in light of the perspective of this study.

chain and Vehicle manufacturing and assembly and Production of components in the automotive chain. Boosting these links must be addressed with an appropriate mitigation strategy to contain their potential impact on the carbon footprint.

Graph 3.1. Integration and decarbonization potential in Colombia



Source: Prepared by the authors based on national studies, sectoral reports, interviews with government entities, interviews with associations and chambers of commerce, and expert criteria.

3.2.2 Identification of productive GVC insertion and decarbonization opportunities

3.2.2.1 Identification of insertion opportunities in GVCs

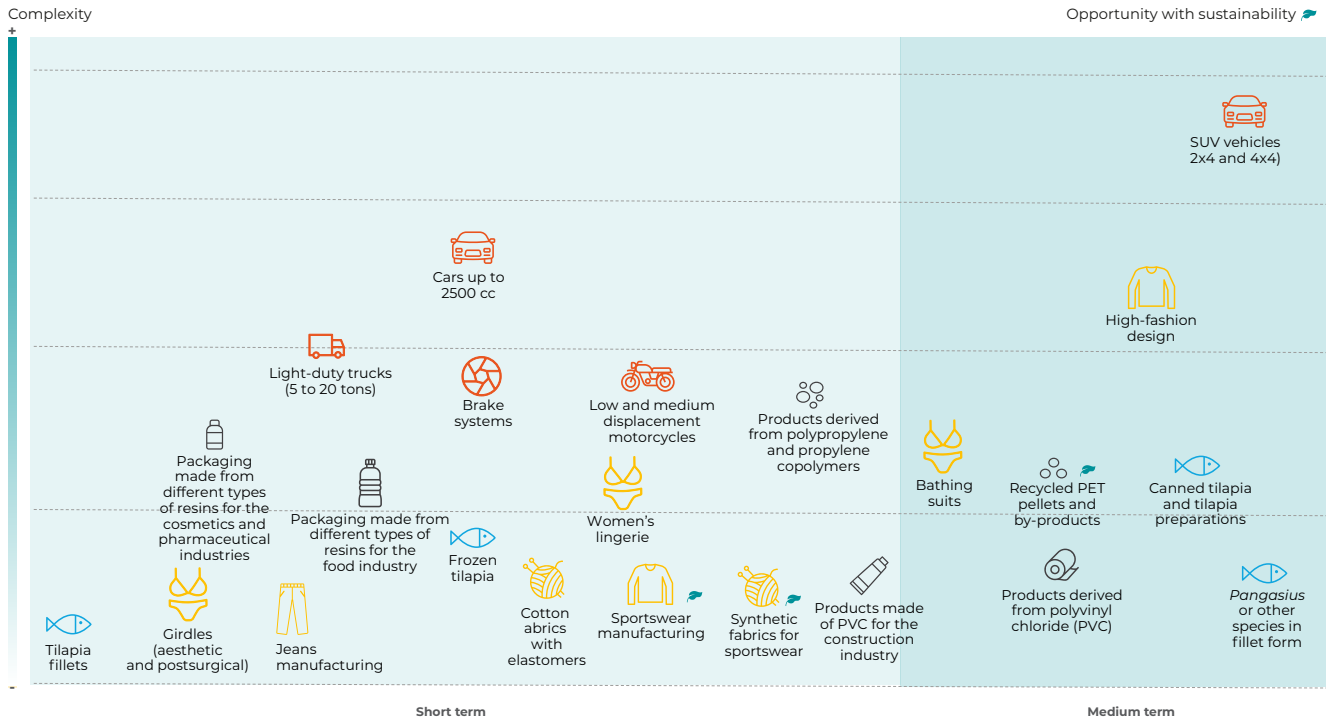
Insertion opportunities refer to specific products with high potential to boost exports and attract investment and that are associated with a strengthening of GVCs. Based on the bottom-up analysis carried out through 44 interviews with representatives of companies, trade associations, and government entities, a total of 23 opportunities for insertion were identified for the four chains analyzed.[52]

Graph 3.2 shows the opportunities identified for Colombia according to their level of economic complexity[53] and time horizon required to achieve the goals associated with these opportunities. As mentioned above, a distinction is made between two major time horizons: the short and medium terms.

52 For more details on the methodology, see the first chapter.

53 In terms of the work of Hausmann *et al.* (2011), that is, linked to the level of sophistication and capabilities required to produce these goods.

Graph 3.2. Range of products identified as opportunities for insertion in GVCs in Colombia



Source: Prepared by the authors based on the methodology described above.

Before discussing in detail the set of opportunities identified for each time horizon and in each chain, it is important to note that three of the opportunities identified correspond to dual opportunities,[54] that is, these integration opportunities lead to a reduction in the carbon footprint of the chains analyzed. These opportunities include sportswear manufacturing, manufacture of synthetic fabrics for sportswear, and production of pellets and products derived from recycled PET.

Among the opportunities for insertion in GVCs with the shortest resolution time were mainly products with a low level of complexity, concentrated in the fishing, textiles and apparel, and plastics and rubber sectors.

In the fishing sector, an opportunity was identified for tilapia fillets, the exports of which to the United States have grown by 4.6 percent annually over the last five years. In addition, there is still ample room to consolidate growth, given that there is currently a network of international distributors, although exports are only made to four states in the United States (see Box 3.1 for more details on the case of tilapia). Frozen tilapia is more complex than tilapia fillets, because although it has a similar or even greater demand potential than fresh tilapia, it requires the incorporation of deep-freezing technologies.

54 Marked with a green leaf next to it.

Box 3.1. The case of tilapia fillets

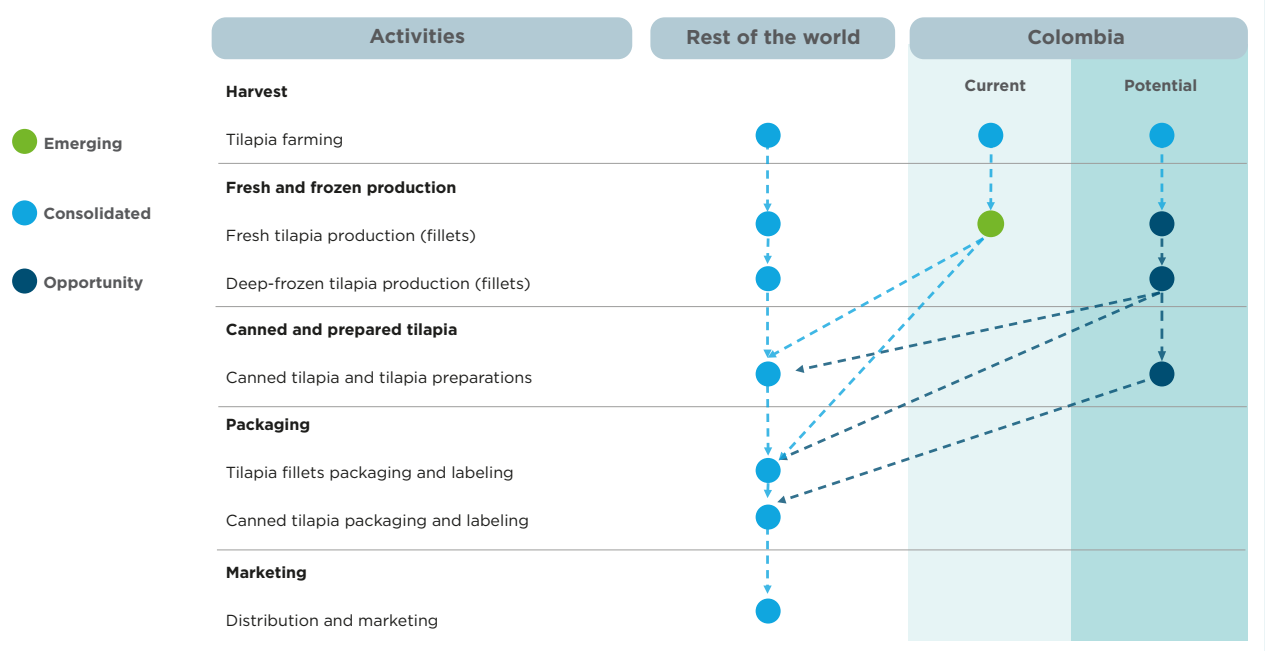
Tilapia was declared a domesticated species in 2015 and, since that year, Piscícola New York, a leading company in the sector, began its accelerated growth, driven by obtaining international certifications for its commercialization.

The company takes advantage of the special temperature and water body conditions of the Betania reservoir, in the Department of Huila, and performs all the activities in the value chain: farming, fattening, processing, marketing, and distribution in the domestic and international markets. Piscícola New York currently holds the largest concentration of companies in the cluster and processes the production of a group of smaller producers.

During the last 10 years, domestic consumption of this product has quadrupled and consumption in the international market has grown as well, largely because it is a substitute for red snapper, which is overfished. China's exports to the United States accounted for 47 percent of that market in 2018, but by 2020 had dropped to 17 percent. In contrast, Colombia's share in this market went from 10 percent in 2018 (US$51.7 million) to 20 percent in 2021 (US$70 million). Of the total exported in that year, Piscícola New York's exports was US$27.7 million. To provide a sense of the size of the U.S. market, tilapia imports had a value of US$337 million in 2021.

Piscícola New York aims at duplicating its exports of frozen tilapia to the U.S. market between 2022 and 2024. Among other activities, they plan to invest US$80 million to expand and consolidate the company's infrastructure and operational capacity, implement good aquaculture practices (GAP), and build a deep-freezing plant to increase the product's shelf life without affecting its condition, so that it can be transported by sea over long distances.

Illustration of potential chain transformation



Source: Prepared by the authors based on a review of sectoral information and fieldwork.

For the textiles and apparel sector, six products were identified as providing opportunities within a relatively short time frame. Firstly, there are girdles and jeans manufacturing. Although these two products have a low level of complexity, their strong market positioning provides greater opportunities for increasing exports. Currently, Colombia is one of the global leaders in girdle production with access to over 50 markets; however, it does not export in large volumes. Therefore, the opportunity lies in deepening its presence in current markets, expanding into new economies, and positioning the country's brand as a symbol of quality and design. In the case of jeans, the U.S. market is demanding more products from the region in order to reduce dependence on Asian suppliers. This presents an opportunity for Colombian companies with differentiators in design, fabric treatment, and quick response. The other four products are cotton fabrics with elastomers, sportswear manufacturing, women's intimate apparel, and synthetic fabrics for sportswear. These products are closely linked to diversification opportunities compared to more-established industry products. In the case of cotton fabrics with elastomers, growth in the exports of these products is tied to increased production of girdles and women's intimate apparel. Similarly, in synthetic fabrics for sportswear, growth requires an increase in manufacturing of this product, which depends on the sector's ability to overcome labor barriers.

Among the opportunities for entry into the GVC with shorter resolution times, products with a low level of complexity were primarily identified, concentrated in the fishing, textiles and apparel, and plastics and rubber sectors.

In the plastics and rubber sector, opportunities were found in packaging using different types of resins for the cosmetics and pharmaceutical industries, as well as the food industry. These opportunities could materialize quickly, because Colombian companies currently have the capabilities to increase production. Additional opportunities are associated with PVC products for construction with low complexity and products derived from polypropylene and propylene copolymers, which have a medium level of complexity. In both cases, companies need to invest in technology in order to expand their access to international markets.

Finally, in the automotive sector,[55] four products that present opportunities were identified, three of which (light trucks, brake systems, and motorcycles) have a similar level of complexity. Among these, the production of light trucks has the potential to be ramped up more quickly, followed by that of brake systems; motorcycles will require more time due to the lack of experienced assemblers in the international market. The opportunity related to vehicles up to 2500 cc will involve a longer time frame due to the higher complexity in their development.

In the medium term, there are opportunities in all sectors with varying levels of complexity. In the case of fishing, tilapia preserves and preparations represent a long-term opportunity, because the sector needs to develop capabilities and infrastructure for exporting products. Similary, in the medium term the sector has the opportunity to explore new low-complexity products, such as *Pangasius* fillets, for which legal procedures need to be advanced so that permits for commercial exploitation can be acquired.

In the textiles and apparel sector, swimwear is a product with potential. It can be marketed quickly; however, its growth depends on the positioning of the country's own brands in the international market

55 In 2022, Colombia's exports of motor vehicles to the United States and LAC totaled US$21 million and US$156 million, respectively.

that sell high volumes. Likewise, in the plastics and rubber sector, there is an opportunity in products derived from PVC, though it requires significant investments in research for their development.

Finally, for the automotive sector, SUV vehicles (2x4, 4x4) were identified as a product with potential, but due to their high level of complexity, it needs more time to consolidate.

3.2.2.2 Identification of decarbonization opportunities

As mentioned earlier, decarbonization opportunities refer to specific actions that can be implemented throughout the production process (such as incorporating recycled raw materials) and marketing (e.g., electrification of transportation) of the analyzed goods to reduce their carbon footprint. The identification of these actions comes from fieldwork conducted through interviews as well as interviews with experts and a review of specialized academic literature.[56]

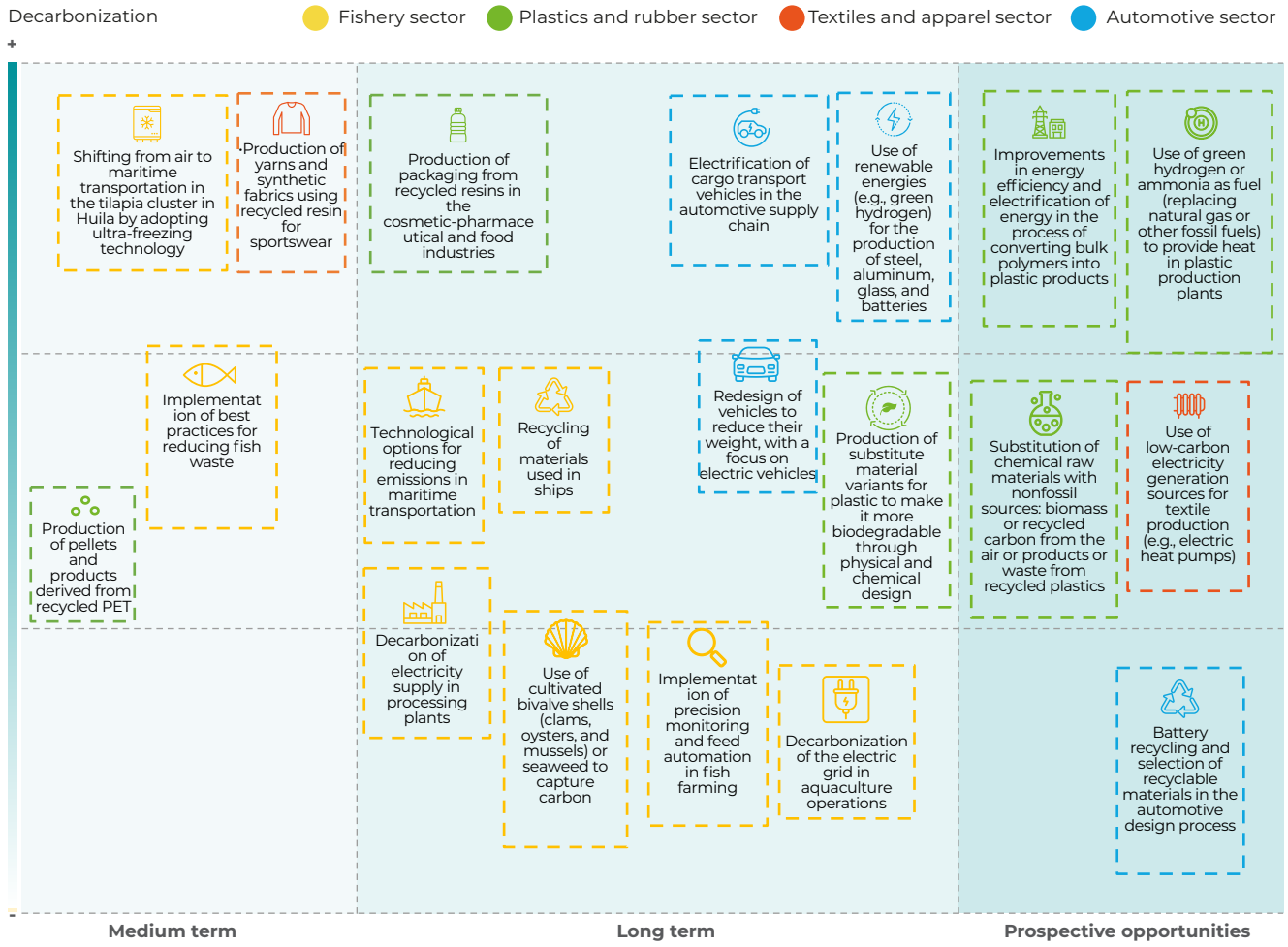
In total, 20 decarbonization opportunities were identified for Colombia. Graph 3.3 shows a characterization of these opportunities, considering both the time horizon and the sector to which they belong. It is worth noting that the classification according to the time horizon used for decarbonization opportunities differs from that used for GVC integration opportunities. Decarbonization opportunities are classified according to the following time horizons: medium term, long term, and prospective opportunities. More than half of the opportunities have a long-term realization horizon. In terms of sectors, decarbonization opportunities are concentrated in the fishing and the plastics and rubber sectors.

The fishing sector presents two decarbonization opportunities in the medium term. The first involves the adoption of ultra-freezing technologies in the tilapia cluster, which would allow the the transportation method to change from air to maritime, thus reducing emissions. It is important to highlight that, in addition to having high decarbonization potential, this product was also identified as having high GVC integration potential, making the opportunity in this case a dual one (i.e., GVC integration and decarbonization simultaneously). Another notable opportunity is linked to the implementation of best practices to reduce fish waste[57] and consequently emissions. An example of this could be behavioral changes, such as reducing the speed of boats and optimizing the location and times used for fish capture, as well as selecting the correct type of fishing gear (line and net) for the target fish.

56 Refer to the details in the bibliography section and footnotes of this chapter.

57 It is estimated that both wild capture and aquaculture involve a degree of discard and loss, which in some fisheries are estimated at 20 to 25 percent (Béné *et al.*, 2015).

Graph 3.3. Range of products identified as decarbonization opportunities in Colombia



Source: Prepared by the authors based on fieldwork.

Turning to the plastics and rubber sector, there is an opportunity in the medium term linked to the production of pellets and derivatives from recycled PET (Box 3.2).[58] This opportunity is associated with investments being made in recycling plants to exploit the characteristics of this reusable resin, turning it into a product that promotes the circular economy (especially in an energy-intensive industry).

In the textiles and apparel sector, an opportunity in the medium term has been identified that involves the production of yarns and synthetic fabrics using recycled resin (Box 3.2), particularly for sportswear production.[59] These products were also recognized as opportunities for GVC integration, making them a dual opportunity.

58 Recycled PET is PET plastic that has undergone a recycling process. Also known as rPET, it is entirely manufactured from recycled materials.

59 The company Enka supplies raw materials to companies like Protela to manufacture textiles using recycled PET resin combined with cotton and other fibers. Recycled PET replaces polyester, which is highly polluting and has a low recycling rate.

Box 3.2. Recycled PET Resins in Antioquia

Enka began operations in Antioquia in 1966 with the purpose of manufacturing and commercializing resins and synthetic fibers based on the production of virgin PET derived from petroleum. In 2007, it defined sustainability as a fundamental axis of its strategy through the implementation of circular economy processes, innovation, and high engineering.

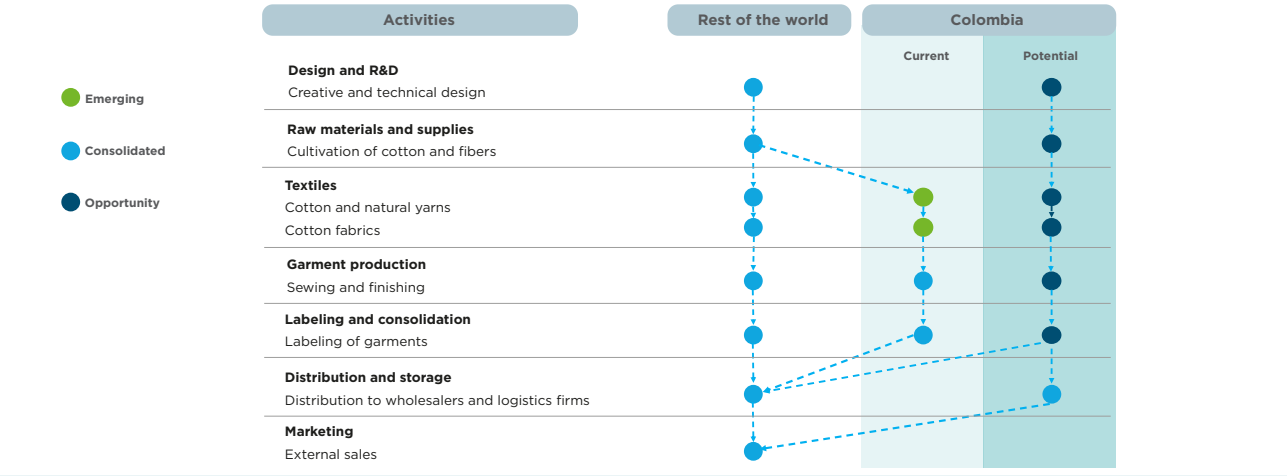
As a result of an investment of US$160 million, the company is one of the world's leading producers of recycled PET resins. It collects 6 million bottles per day and has the capacity to process over 100,000 tons annually. The company is the main manufacturer of Nylon 6 canvas for tire production in America, supplying Goodyear, Bristol, and Continental. It is also the largest producer of filaments and synthetic fibers in the Andean Region and one of the key players in Latin America. By the end of 2023, the company plans to have products based on the recycling of postconsumer PET bottles manufactured in the largest PET plant in South America, which will represent 70 percent of its products.

Enka has created a subsidiary, Eko Red, that is dedicated to bottle collection in 900 municipalities. Besides promoting recycling, it generates employment, formalizes productive units, and increases the income of thousands of recyclers, disbursing over US$45 million annually to them. In 2021, 80 percent of Enka's sales were of products developed in the last 10 years. It sold 60 percent of its total production in Colombia and the balance was exported to the United States, Canada, Mexico, Brazil, Argentina, and Peru.

Opportunities

- The company expects to develop and commission a new plant for the production of recycled PET resins in Bogotá or on the Atlantic coast between 2025 and 2026. Depending on the location and size, this project may require US$40 to 50 million of investment.
- With this investment, Enka aims to replace the import of fibers from the Asia-Pacific region with products based on recycling and a diversified portfolio to strengthen its exports to Latin America and the United States. It also hopes to assist national bottling companies in meeting regulatory requirements that will limit the use of single-use plastics starting in 2025.

Illustration of the potential transformation of the textile chain



Source: Prepared by the authors based on a review of sectoral information and fieldwork.

Considering the long-term time horizon, a total of 11 opportunities were identified. In the case of the fishing sector, six opportunities were identified: the decarbonization of the electricity supply in fish-processing plants,[60] the use of carbon sinks in aquaculture (for example, clams, mussels, oysters, or seaweed),[61] the implementation of monitoring and automation to avoid waste in aquaculture (using cameras, sensors, and artificial intelligence to optimize the quantity and timing of food release), the electric decarbonization of aquaculture operations (for example, through floating solar energy or wave energy generators)[62] and the replacement of diesel fuels with zero-emission alternatives, the use of technological options to reduce emissions from maritime transport[63] (for example, by optimizing hull design, power and propulsion systems, using alternative fuels and energy sources, and making changes in operations such as adapting speed to sea conditions for maximum efficiency), and the recycling of materials used in ships (especially steel[64] and aluminum).

The plastics sector has two opportunities within this time horizon. First, there is the production of packaging from recycled resins for the cosmetic-pharmaceutical and food industries.[65] These products were identified above in terms of opportunities for GVC integration. Another decarbonization opportunity in this chain consists of the possibility of producing substitute variants of plastic that would be more biodegradable. This would require completely new polymer chemistries (Gandini, 2008; Hatti-Kaul *et al.*, 2020) that enable, through physical or chemical design, making current plastics more recyclable or capable of biodegrading into harmless materials.

Within the automotive sector, three long-term opportunities were identified. First, there is the redesign of vehicles to make them lighter,[66] as well as the prioritization of the manufacturing of electric vehicles (Crabtree, 2019; Kawamoto *et al.*, 2019; Rietmann *et al.*, 2020). Second, there is the electrification of transportation elements in the automotive supply chain (both finished products and intermediate components). Lastly, there is the emphasis on using renewable energies (e.g., green hydrogen) for the production of steel, aluminum, glass, and batteries.

60 Most processes found in a typical fish-processing plant are electrical or suitable for electrification.

61 A sink refers to any system or process that extracts and stores gases from the atmosphere (e.g., CO_2). Oceans are considered the primary natural carbon sinks, capable of absorbing around 50 percent of the CO_2 emitted into the atmosphere. Plankton, corals, fish, algae, and other photosynthetic bacteria are responsible for this capture.

62 Some of the studies that have investigated the integration of renewable energy into aquaculture operations are Vo *et al.* (2021), Bujas *et al.* (2022), and Scroggins *et al.* (2022).

63 Responsible for transporting 80 percent of global trade.

64 The value of scrap steel is the main driver of recycling activities (Sornn-Friese *et al.*, 2021).

65 Representative companies such as Simex and Multidimensionales, dedicated to manufacturing packaging for the cosmetic and personal care industries and the food industries, respectively, have implemented strategies for self-generation of energy from solar panels to meet part of their energy needs. Multidimensionales also invests in research to integrate recycled resins into its production processes without impacting the conditions of the packaging.

66 One of the most significant ways to reduce energy usage is to reduce the vehicle's mass (Kacar *et al.*, 2018; Czerwinski, 2021; Shaffer *et al.*, 2021).

Finally, in the case of prospective opportunities, five were identified. In the automotive sector, an opportunity was found: battery recycling and the selection of recyclable materials throughout the automotive design process. In principle, almost all parts of a vehicle can be recycled. In this way, manufacturers can play a significant role in improving the recyclability of vehicles during the design process, either by selecting easily recyclable materials or structuring vehicle components for easy disassembly for reuse as spare parts or for separation of them for individual recycling (Aguilar Esteva *et al.*, 2021; Baars *et al.*, 2021; He *et al.*, 2021). This applies particularly to battery packs (Harper *et al.*, 2019; Bauer *et al.*, 2022), but also to other structural components such as windshields or tires (McAuley, 2003; Nakano & Shibahara, 2017; Soo *et al.*, 2017).

In the case of the textile sector, an opportunity linked to the use of low-carbon electricity- generation sources for production was identified (e.g., through the use of heat pumps). Electricity supplies much of the energy needed for lighting, motors, etc., in textile plants, making decarbonization of the grid a requirement for achieving net-zero textile manufacturing.[67]

The plastics sector has three associated opportunities. The first is improving energy efficiency and electrification in the conversion process of bulk polymers into plastic products to reduce emissions (Van Geem *et al.*, 2019; Negri & Ligthart, 2021). Secondly, there is the use of green hydrogen or ammonia as fuel to supply heat in plastic production plants, replacing natural gas or other fossil fuels. Finally, a relevant opportunity is the substitution of chemical raw materials with nonfossil sources (such as biomass,[68] recycled carbon from the air,[69] and products or waste from recycled plastics[70]) in the plastic-manufacturing process. This would enable the elimination of emissions associated with the extraction of oil or natural gas from the product life cycle.

67 The heating requirements in textile production range from 40°C to 160°C, with the upper end of the range used for dyeing. Electric heat pumps can already supply heat in the range of 90°C to 150°C, and solutions to surpass 150°C are already successfully completing demonstration projects (Arpagaus *et al.*, 2018). Therefore, complete electrification of textile production with decarbonized grid electricity is already a technical possibility.

68 Replacing fossil raw materials with biomass is a common recommendation in studies exploring emission reduction in plastic production (Zheng & Suh, 2019; Scott *et al.*, 2020; Saygin & Gielen, 2021).

69 In principle, carbon from CO_2 can be combined with hydrogen from water to create the hydrocarbons needed to manufacture any type of plastic (Palm *et al.*, 2016; Palm & Svensson Myrin, 2018; Lange, 2021).

70 A third potential source of carbon for use as raw material for plastics is actually the recycling of plastic waste (Carus *et al.*, 2020) or waste raw materials (Moretti *et al.*, 2020).

3.3 Strategy for sustainable value chains in Ecuador

3.3.1 Identification of links with high potential

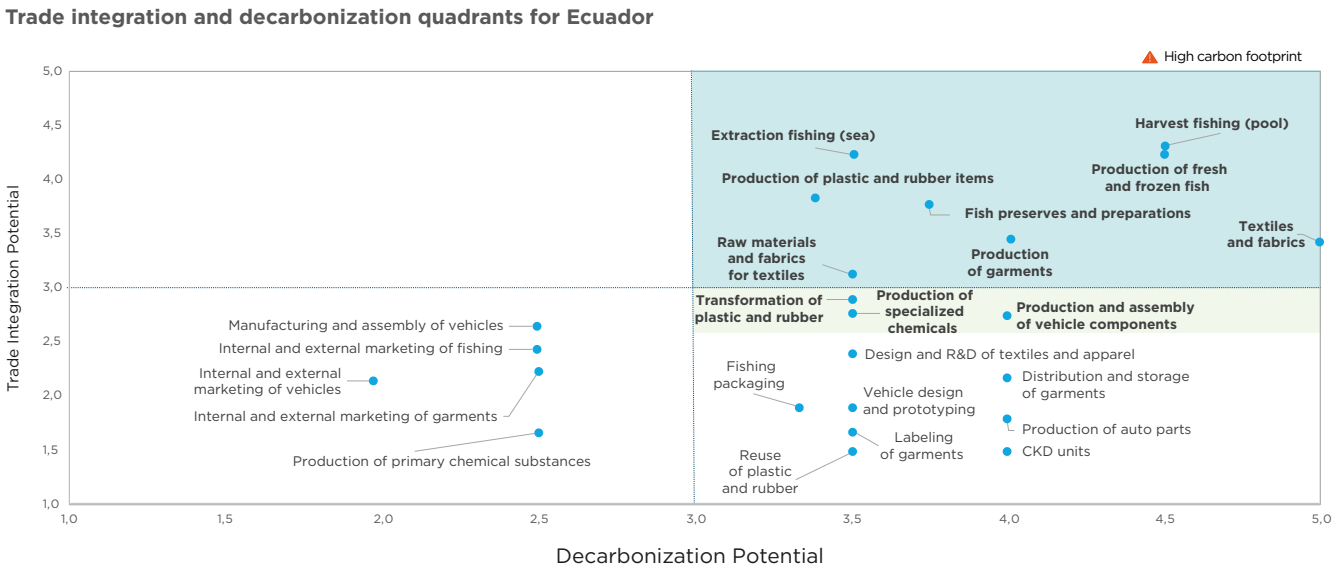
In terms of integration potential, the links that stand out in Ecuador are mainly associated with fishing, from extraction and harvesting of fish, crustaceans, and mollusks to their preparation and preservation. Additionally, the production of plastic items in the plastics and rubber chain is highlighted, as well as the existence of potential in various links of the textiles and apparel chain, especially in knitted garments.

Graph 3.4 shows a dual view of the potential of the analyzed links that considers both value chain integration and decarbonization potential. Eight links are identified that have a high potential for strengthening value chain integration and reducing the carbon footprint of the associated sector (blue area of the graph). This quadrant includes links such as Harvest fishing, Production of fresh and frozen fish, and Production of plastic and rubber items.

This set of high-potential links is extended to incorporate others that, despite having somewhat lower value chain integration potential, have a high decarbonization capacity (green area of the graph). In Ecuador, these links include Production and assembly of vehicle components, Production of specialized chemicals, and Transformation of plastic and rubber. This is where the fieldwork conducted for this study was mainly focused and the majority of opportunities are concentrated.

In the lower-left quadrant, there are links with low potential for both value chain integration and decarbonization, such as Manufacture and assembly of vehicles and Internal and external marketing of fishing. Finally, in the lower-right quadrant below the green area, there are links with high decarbonization potential but low value chain integration potential, such as Design and R&D of textiles and apparel.

Graph 3.4. Integration and decarbonization potential in Ecuador



Source: Prepared by the authors based on national studies; sector reports; interviews with representatives of government entities, associations, and chambers of commerce; and expert opinions.

3.3.2 Identification of value chain insertion and decarbonization opportunities

3.3.2.1 Identification of opportunities for inclusion in value chains

Based on the field analysis (or bottom-up approach) conducted through interviews with representatives of companies, associations, and government entities, 29 opportunities for inclusion in regional value chains[71] were identified across the four analyzed chains.[72] Graph 3.5 shows the opportunities identified for Ecuador according to their level of economic complexity[73] and the time horizon required for them to be realized.

It is worth noting that, in the case of Ecuador, 25 out of the 29 identified opportunities are categorized as dual opportunities, meaning they are associated with both inclusion in GVCs and decarbonization.[74] Some examples of dual opportunities include Tuna preparations, Frozen shrimp, and Plastic pipes.

Considering the time horizon for materialization, 14 out of the 29 opportunities can be realized in the short term, while the remaining 15 can be realized in the medium term. Sector-wise analysis reveals that the fishing sector plays a prominent role, with 14 of the 29 opportunities found. It is followed by the plastics and rubber sector and the textiles and apparel sector, with 7 and 6 opportunities, respectively. Lastly, the automotive sector has 2 associated opportunities.

The listed opportunities include goods associated with different production processes. In the case of products like frozen fish, which involve only the freezing chain, production can be expanded while the low complexity is maintained. Products like denim fabrics, requiring specialized machinery and human capital with specific knowledge, were also identified. These are associated with greater financial outlays, as well as production that involves more time and processes of higher complexity for production.

In the short term, opportunities are observed across all four sectors. In the fishing sector, mainly products with low complexity were found: frozen fish (tuna and swordfish), tuna preparations, and sardine preparations. In all these cases, the processes are already developed, with available installed capacity, positioning, and scale of exports globally, translating into a significant opportunity for diversification and expansion of products in high-demand markets associated with innovation in nontraditional and high-value-added goods.

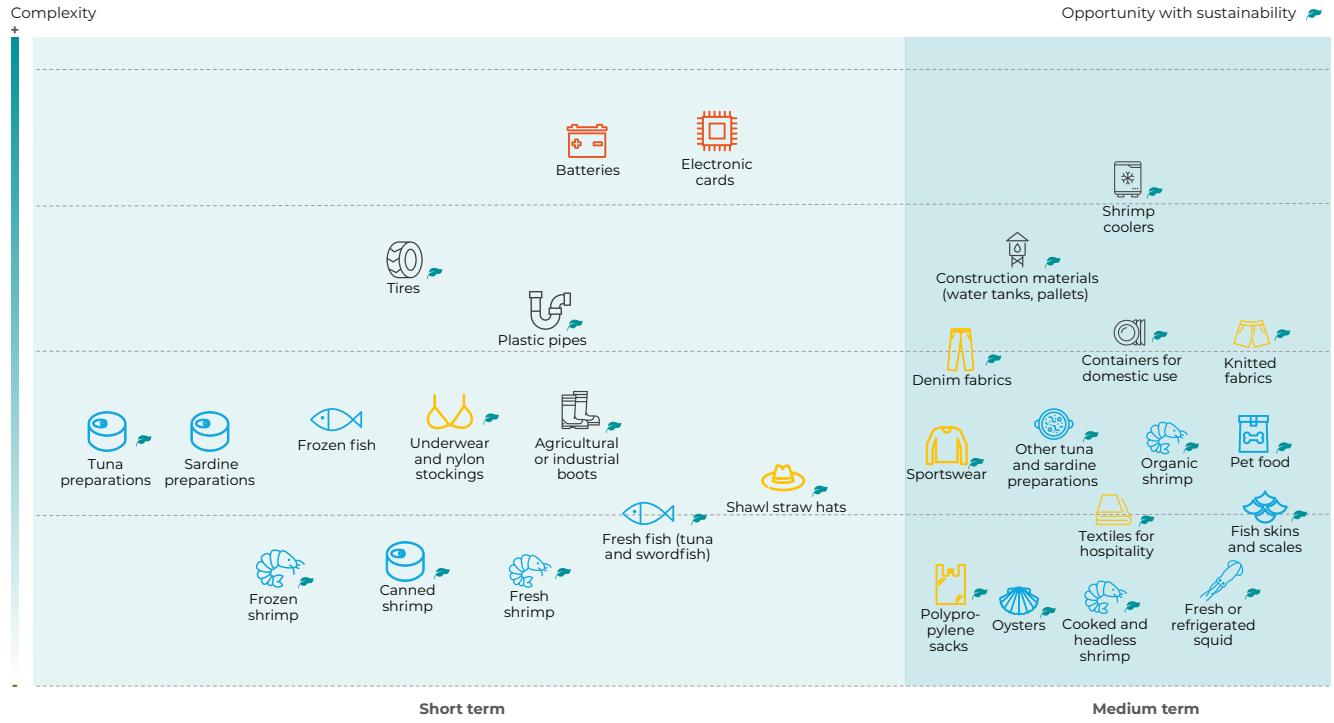
71 Commercial insertion opportunities refer to specific products with high potential to boost exports and attract investments, associated with strengthening regional value chains.

72 For a detailed methodology, refer to the first chapter.

73 In terms of the work by Hausmann *et al.* (2011), that is, linked to the level of sophistication and capabilities required to produce those goods.

74 Indicated with a green leaf next to them.

Graph 3.5. Range of products identified as opportunities for insertion in GVCs in Ecuador



Source: Prepared by the authors based on the methodology described above.

In this sector, there are also products with a lower associated level of complexity. An increase in production will require the acquisition of additional capabilities, such as machinery and/or special facilities, the processes have already been developed in the country and the necessary expertise for production is available. As shown in Graph 3.5, these products include fresh fish (tuna and swordfish) and frozen, canned, and fresh shrimp.

In the cases of textiles and apparel and plastics and rubber, the opportunities are associated with a medium level of complexity. Unlike fishing-sector products, these require the development of additional capabilities for production, although similar procedures are already being implemented. In the textiles and apparel sector, two products of medium complexity were identified: underwear and nylon stockings and shawl straw hats. Products in the plastics and rubber sector include tires, plastic pipes, and agricultural or industrial boots. The first two have a slightly higher level of complexity.

In the automotive sector, the opportunities are of high complexity because industries require the extensive development of capabilities and the necessary technology. These requirments are not easily met, because highly skilled professionals are needed. Batteries and electronic cards are the identified opportunities for this sector (see Box 3.3).

Box 3.3. The case of electronic cards

Tarpuq, based in Cuenca, began operations in 2013 as a technological innovation project in the country. It was the first company to provide electronic manufacturing services on the Pacific coast of South America.

Its plant has two surface-mount technology (SMT) production lines and one through-hole technology (THT) production line. All its processes are strictly monitored and products go through an individual review phase before delivery. This has enabled the company to obtain certifications such as ISO 9001:2015 for product quality and IPC for the standardizing of assembly requirements and production of electronic equipment and assemblies.

Among Tarpuq's client portfolio are notable companies such as Alcatel, Indurama, Toyota, Mazda, General Motors, Samsung, Daewoo, Hyundai, and Motorola.

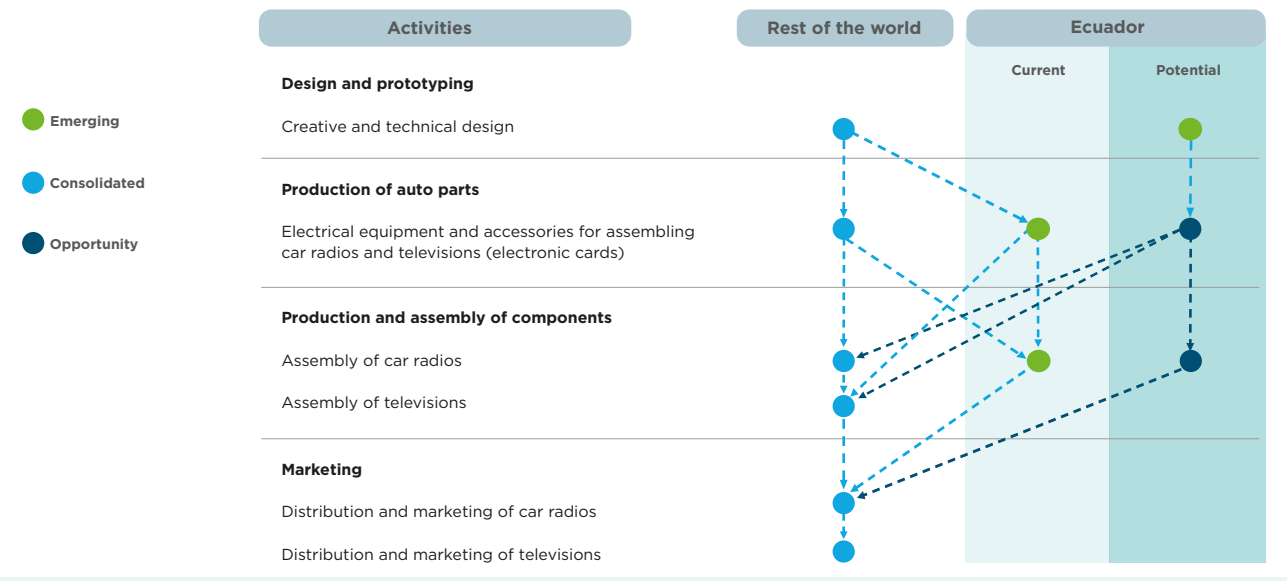
Currently, the company exports finished products such as televisions and car radios where the electronic card is a component of the product.

The company's sales approached US$9 million in 2021, of which 10 percent were exports that went to 10 countries in the region, among them Mexico, Colombia, Peru, Bolivia, Uruguay, Chile, and other Central American countries.

Opportunities:

- Increase exports of electronic cards in finished products to Colombia and Mexico, markets where the company already has a presence and high growth potential.
- Introduce the company's products into new countries such as the United States and Brazil.
- To realize these two goals, the company needs financing ranging from US$15 to 30 million, with a maximum return on investment between one and two years. The obtained credit will be allocated to working capital, product development (application of cards in finished systems), and market expansion.

Illustration of potential chain transformation



Source: Prepared by the authors based on the review of sectoral information and fieldwork.

Finally, in the medium term, there are opportunities of different complexity levels within the fishing, textiles and apparel, and plastics and rubber sectors. They differ in that all involve processes not yet implemented by companies, which requires planning, capacity development, and strengthening of current production processes, as well as the elimination of bottlenecks, in some cases structural, that may be affecting their production. However, they also present opportunities with higher value-added generation, paving the way for significant participation within GVCs.

These types of opportunities can also have positive spillover effects on the Ecuadorian economy by increasing the necessary linkages to sustain production, improving the quality of work, increasing innovation and knowledge and technology transfer, and boosting company productivity.

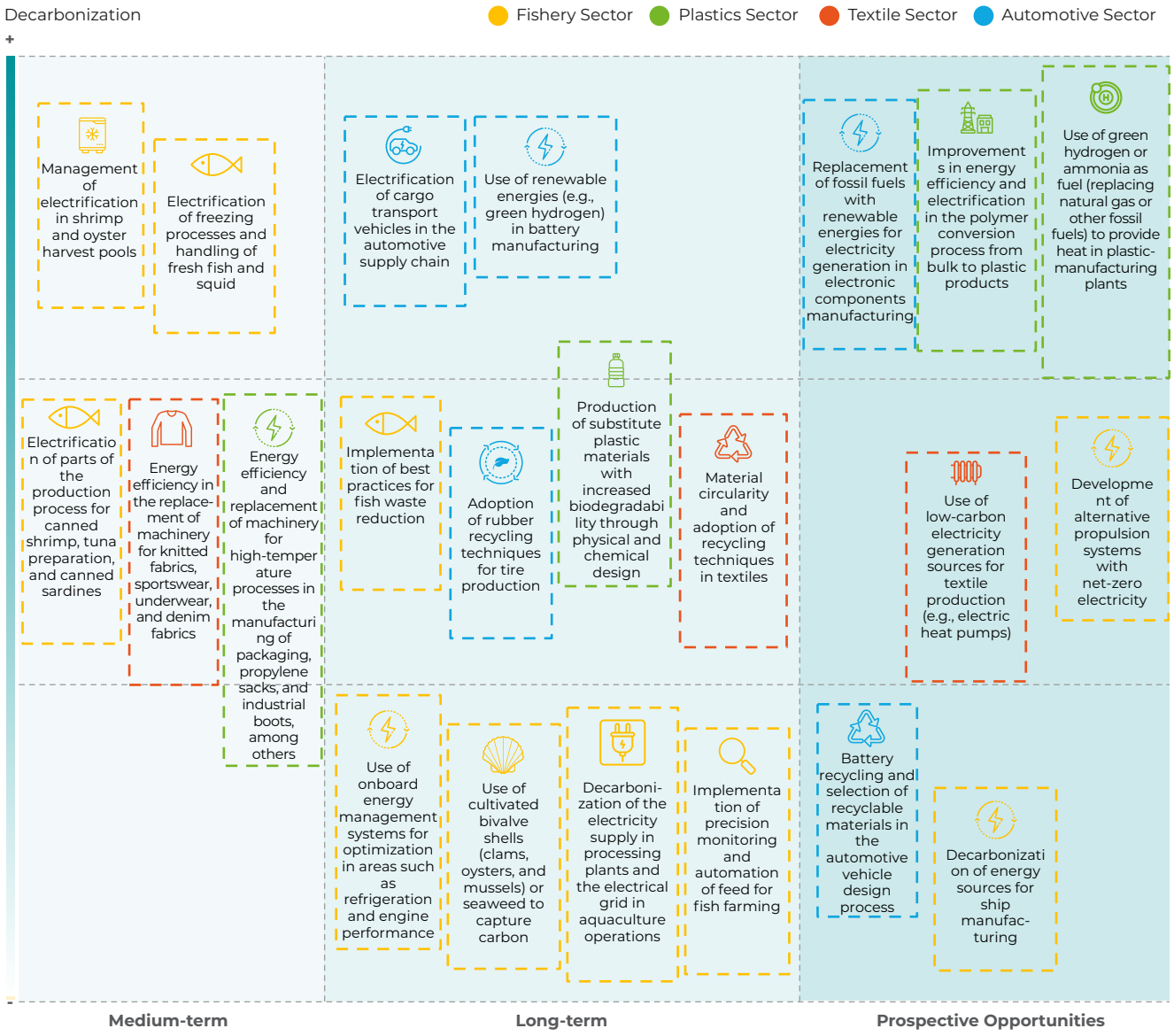
In the fishing sector, identified opportunities include oysters, other tuna and sardine preparations, cooked and headless shrimp, organic shrimp, fresh or refrigerated squid, pet food, and fish skins and scales. For the textiles and apparel sector, opportunities include sportswear, denim fabrics, textiles for hospitality, and knitted fabrics. Finally, for the plastics and rubber sector, identified opportunities are polypropylene sacks, containers for domestic use, construction materials, and coolers for shrimp.

3.3.2.2 Identification of Decarbonization Opportunities

As mentioned earlier, decarbonization opportunities refer to specific actions that can be implemented throughout the production process (e.g., the incorporation of recycled raw materials) and commercialization (e.g., electrification of transportation) of the analyzed goods to reduce their carbon footprint. In total, 22 decarbonization opportunities were identified for Ecuador. Graph 3.6 presents a characterization of these opportunities that considers both the time horizon and the sector to which they belong. In terms of sectors, the greatest decarbonization opportunities are in the fishing sector, although relevant opportunities have also been identified in the other the sectors.

As can be seen, in the medium term the fishing sector presents three decarbonization opportunities. Most of the projects are related to the electrification of shrimp farms and the renewal of the fishing fleet. According to the representatives of the companies who were interviewed, this would bring about a reduction in emissions due both to the gradual decrease in fossil fuels and the increased efficiency these projects would generate. A significant advantage of these projects is that, if financing were to become available, they are relatively easy to develop, as well as being easy for any productive company to adopt because of their generic nature. Because products such as tuna, sardines, and frozen fish present opportunities for trade integration and there are the aforementioned electrification opportunities within their production processes, the are considered dual opportunities.

Graph 3.6. Range of products identified as decarbonization opportunities in Ecuador



Source: Prepared by the authors based on the methodology described above.

In the textile sector, energy efficiency resulting from the upgrading of machinery used in the production of items such as knitted fabrics, sportswear, underwear, and denim has been identified as a medium-term opportunity (see Box 3.4 for details on a specific case). According to interviews conducted with representatives companies in the sector, this could lead to a reduction in diesel consumption of approximately 33 percent. These products were also recognized for potential opportunities in GVC integration, thus representing a dual opportunity.

Box 3.4. The case of sports apparel and nylon socks

INGESA, established in 1963, is currently a leading manufacturer of nylon stockings in Ecuador. The company has the international quality certifications Sedex, SMETA and Sanitized incorporated throughout its production process. In addition, it is vertically integrated, which enables tracking from the nylon spinning process to the packaging stage.

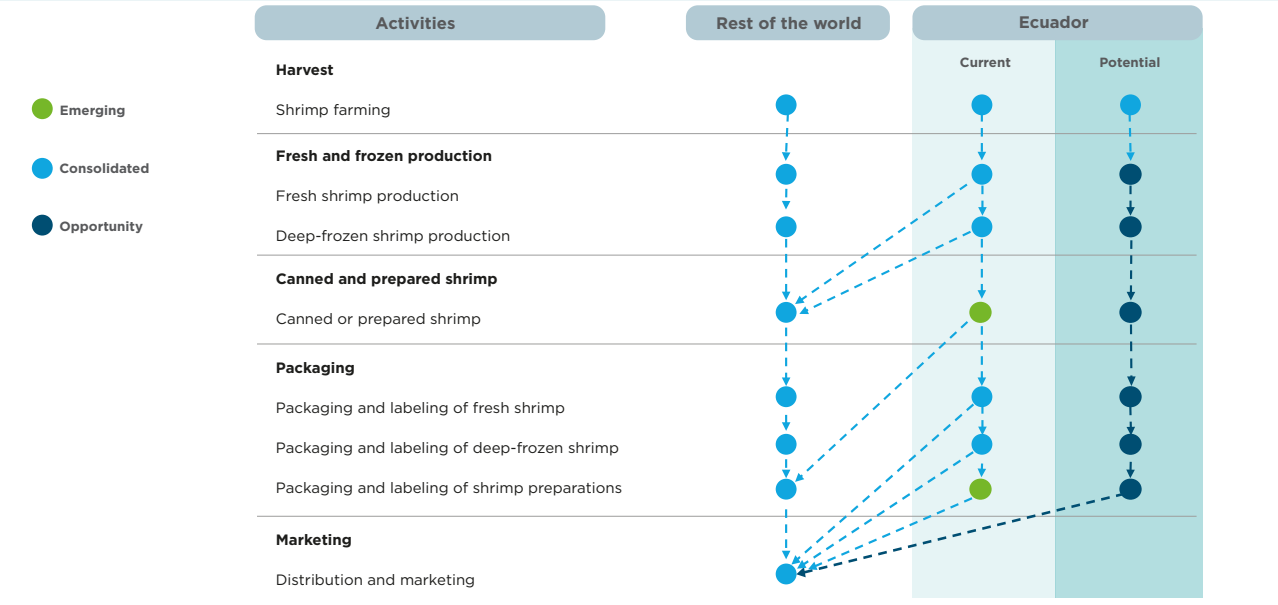
The company has three brands: INGESA, which offers nylon stockings and masks; TSX Sportswear, a line of seamless sportswear for men and women; and Tess Underwear, women's underwear. The entire production process employs 433 workers, 70 percent of whom are women.

INGESA's products and its other brands are offered in both the domestic and international markets. In the local market, it distributes its products to Corporación Favorita and Fybeca. Its international sales take place in markets such as the United States, Peru, Puerto Rico, Bolivia, Chile, Panama, and Mexico; the U.S. market is the main destination for its exports, where the company has clients such as Walmart. As of the second half of 2022, INGESA's exports represented 20 percent of its total production.

The company is currently seeking to expand its participation in the U.S. and Peruvian markets by selling thermal, maternity, underwear, sports, and nylon stockings, based on having the advantage of product acceptance in these markets and certifications that support its quality. The company also aims at entering the Canadian market and other countries in Central America.

The company is also seeking to expand its production capacity. To do so it expects to obtain an estimated US$2 million in financing, which will be invested in the purchase of machinery for the production, weaving, dyeing, and drying processes. Exports are expected to increase as a result of the reduction in time-to-market[75], in addition from having technology oriented to each specific process and to the constant development of fibers and final products.

Illustration of potential transformation of value chains



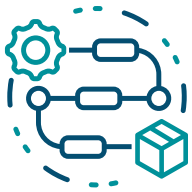
Source: Prepared by the authors based on a review of sector information and field work.

75 The time that elapses from the moment a product or service is conceived until it is market launched.

With regard to the plastics and rubber sector, the main decarbonization opportunity is linked to energy efficiency and replacement of machinery used in high-temperature processes in the manufacturing of packaging, propylene bags, and industrial boots.

Considering the long-term time horizon, a total of 10 opportunities were identified. Half of these pertain to the fishing sector: the implementation of monitoring and automation to avoid waste in aquaculture (through cameras, sensors, and the use of artificial intelligence to optimize the quantity and timing of food release); the use of carbon sinks in aquaculture (in the form of the shells of clams, mussels, and oysters, or seaweed); the use of onboard energy management systems for optimization in areas such as cooling and engine performance; decarbonization of the electricity supply in fish processing plants, and the implementation of best practices for fish waste reduction.

The plastics sector has an opportunity within this time horizon that lies in the possibility of producing substitute variants of plastic to make it more biodegradable. This would require entirely new polymer chemicals (Gandini, 2008; Hatti-Kaul *et al.*, 2020) that, through physical or chemical design, would enable current plastics to be more recyclable or capable of biodegradation.



Decarbonization opportunities refer to specific actions that can be implemented throughout the production and trading processes of the analyzed goods to reduce their carbon footprint.

An opportunity exists within the textile sector that relates to the circularity of materials and the adoption of recycling techniques—in other words, promoting a shift in the production of higher-quality garments with greater longevity and durability, a trend that has already begun in the country.[76]

Within the automotive sector, three opportunities were identified, the first of which is the electrification of transport elements in the automotive supply chain (both finished products and intermediate components). The second is the use of renewable energies (e.g., green hydrogen) for the manufacturing of steel, aluminum, glass, and batteries and the third is the adoption of rubber recycling techniques for tire production.

Seven prospective opportunities were identified. The plastics sector has two associated opportunities, the first of which is improvement in energy efficiency and electrification in the conversion process of bulk polymers into plastic products to reduce emissions (Van Geem *et al.*, 2019; Negri & Ligthart, 2021). Secondly, there is the use of green hydrogen or ammonia as fuel to supply heat in plastic manufacturing plants, replacing natural gas or other fossil fuels.

In the automotive sector, two opportunities were identified, the first of which is battery recycling and the selection of recyclable materials throughout the design process of automotive vehicles. Another opportunity is the use of renewable energies instead of fossil fuels for electric power generation in the manufacturing of electronic components.

In the case of the textile sector, an opportunity was identified related to the use of low-carbon electricity-generation sources for production (for example, through the use of heat pumps).

Electricity supplies much of the energy needed for lighting and motors, for example, in textile plants, so decarbonization of the grid is a requirement for net-zero textile manufacturing.

76 The Ecuadorian slow fashion company Remu Apparel has initiated this type of fashion production (Pohlmann & Muñoz-Valencia, 2021).

Finally, the fisheries sector has two opportunities associated with the redesign of the fishing fleet. The first is to decarbonize energy sources used in the manufacturing process, while the other is to develop propulsion systems that run on net-zero electricity generated from alternative sources rather than the burning of fossil fuels.

3.4 Strategy for sustainable value chains in Peru

3.4.1 Identification of links with high potential

In the case of Peru, the links identified with the greatest potential for integration into GVCs are extraction, harvesting, production of fresh and frozen products, and canned and prepared products in the fishing chain; raw materials, textiles and fabrics, and production of garments in the textiles and apparel chain; and transformation of plastics and rubber, and production of articles in the plastics and rubber chain.[77]

Graph 3.7 shows the dual view of the potential of the links analyzed, including both integration and decarbonization potentials. First, in the upper right, there is a set of links with the dual potential to increase exports through chain-shortening initiatives and to reduce CO_2 emissions through such initiatives (blue area of the graph). Within this group are activities such as Production of fresh and frozen fish, Fishing by harvesting, and Textiles and fabrics.

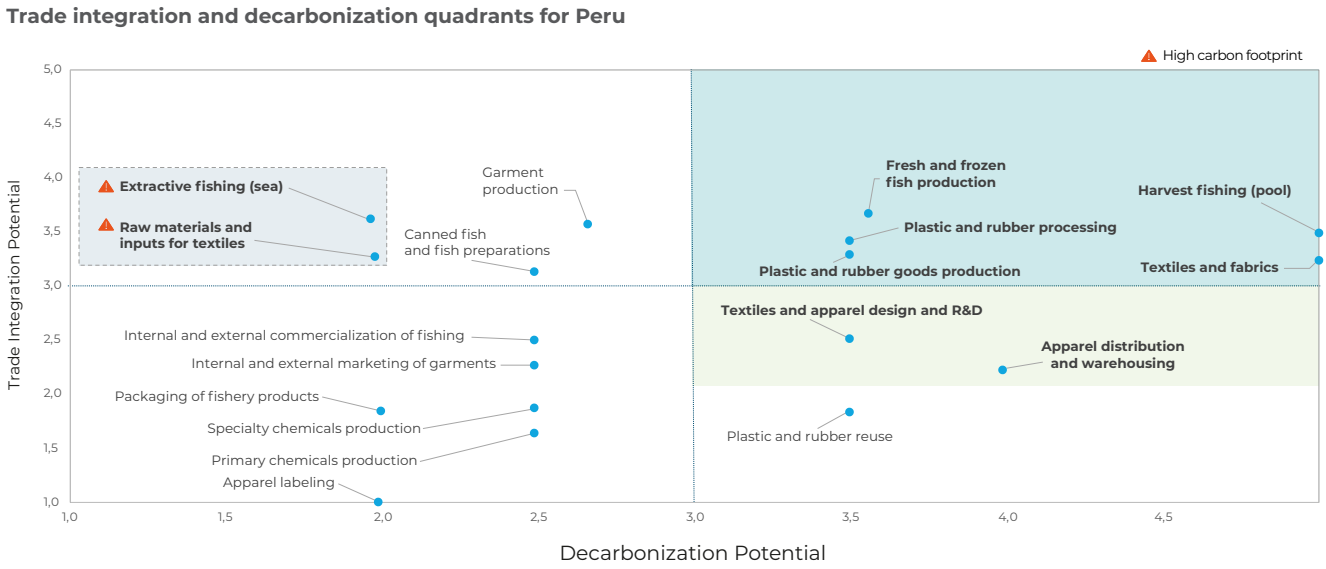
This set of high potential links is extended to incorporate links that, despite having less GVC integration potential, have a high decarbonization capacity (green area of the graph). In the case of Peru, these links are Distribution and storage of clothing and Design and R&D in textiles and apparel. These two blocks constitute the main focus of the fieldwork and are where most of the opportunities are concentrated.

In the lower left quadrant, there are links with low potential for both integration and decarbonization, such as Specialty chemical production. Likewise, in the lower right quadrant below the green area is the link Plastic and rubber reuse that, although it has a high decarbonization potential, has a low integration potential.

Similarly, a set of links with a high level of GVC integration potential but a low level of decarbonization potential appears in the upper left. Within this group, a subset of links with high initial levels of carbon footprint (marked in the gray box in Graph 3.7) is highlighted. These links are Fishing by extraction and Raw materials and inputs in the textiles and apparel chain. The other links that complete this quadrant, with a lower impact on the carbon footprint, are Production of clothing and Canning and preparation of fish.

77 In the case of Peru, the automotive sector was not included because it was not considered a high-potential sector in the previous study.

Graph 3.7. Trade integration and decarbonization potential in Peru



Source: Prepared by the authors based on national studies; sector reports; interviews with representatives of government entities, associations, and chambers of commerce; and expert opinions.

3.4.2 Identification of opportunities for trade integration and decarbonization

3.4.2.1 Identification of opportunities for integration into GVCs

Based on field analysis, 15 opportunities were identified in the 3 analyzed chains for Peru[78] that could increase its participation in GVCs, with 7 of them being short-term opportunities and 8 medium-term. Graph 3.8 shows the opportunities identified for Peru according to their level of economic complexity[79] and the time horizon required for them to be realized. As mentioned earlier, a distinction is made between two major time horizons: the short and the medium terms.

Out of the total opportunities identified, 8 are dual opportunities for enhancing both integration into GVCs and decarbonization.[80] Some examples of dual opportunities identified in Peru include Frozen shrimp tails, Canned anchovies and preparations, and PET and high-density polyethylene preforms and caps.

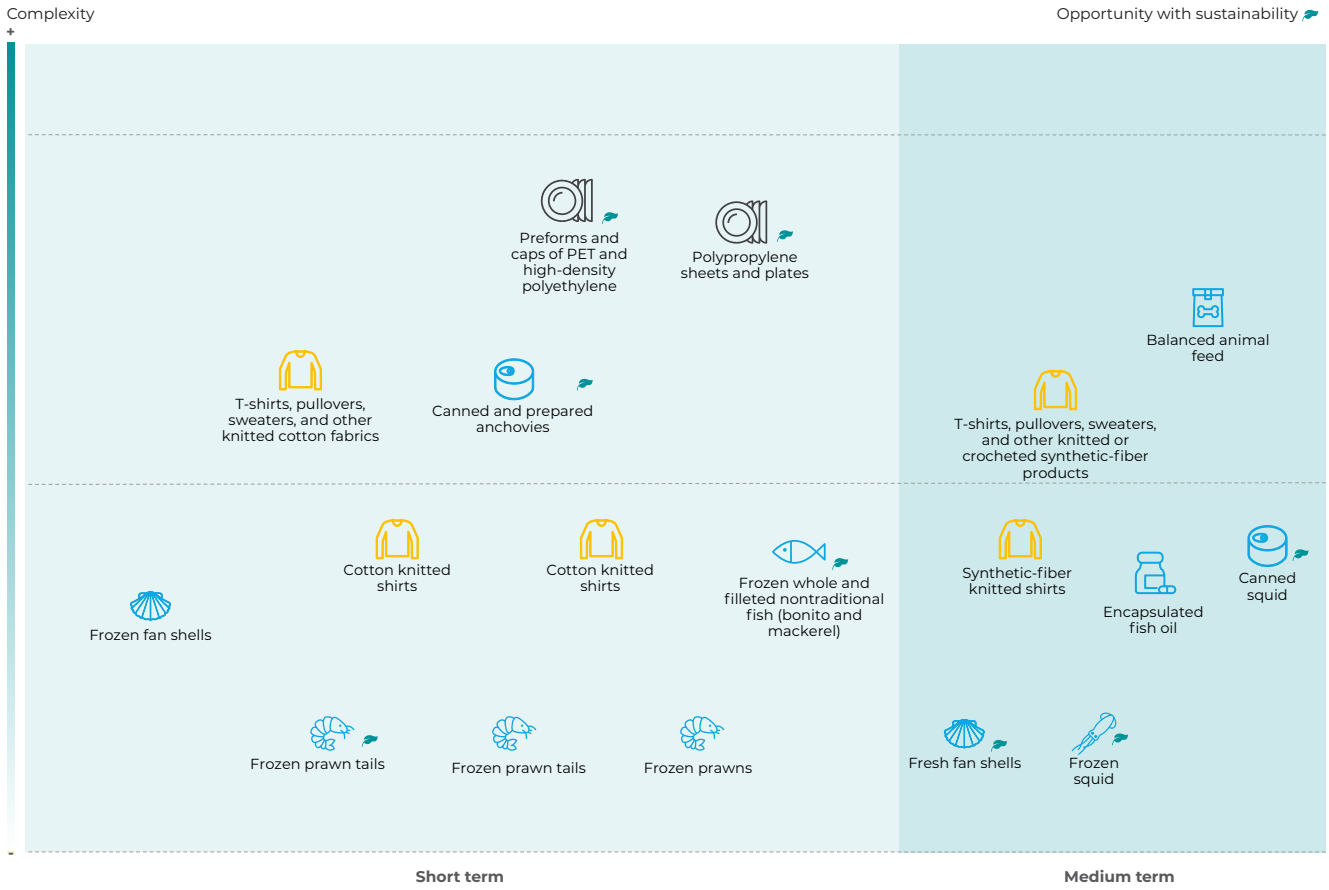
The sectoral analysis reveals that the fishing sector plays a prominent role, with 9 out of the 15 identified opportunities. It is followed by the textiles and apparel sector with 4 associated opportunities. The plastics and rubber sector has the remaining 2 opportunities.

78 In the case of Peru, the automotive chain is excluded from the analysis, given that it is still at a highly incipient level of development.

79 In terms of the work of Hausmann *et al.* (2011), that is, linked to the level of sophistication and capabilities required to produce these goods.

80 Identified with a green leaf next to it.

Graph 3.8. Range of products identified as opportunities for insertion in GVCs in Peru



Source: Prepared by the authors based on the methodology described above.

In the short term, a total of seven opportunities exist, distributed across the three analyzed sectors. The listed opportunities include goods that undergo various transformation processes. For instance, products like frozen scallops, the transformation process of which involves only the freezing chain, have low complexity for production expansion. In contrast, higher-value-added products, such as balanced animal feed, require, for example, specialized machinery and human capital with specific knowledge, implying a more-complex and time-consuming production process, along with other specific requirements.

The opportunities identified in the fishing sector are the least complex, because their production simply requires the acquisition of additional tools such as machinery and/or special equipment. The country has developed processes and the necessary expertise for their production. In this sector, four opportunities were identified: frozen scallops, whole and tail frozen shrimp, cleaned and filleted frozen "nontraditional" fish species, and canned anchovies and preparations (see Box 3.5 for details on a particular case in this chain).

Box 3.5. The case of Transmarina

Transmarina, founded in 1980, is a medium-sized company with Ecuadorian and Peruvian capital. The company specializes in the production of canned fish, fishmeal, frozen fish, and squid. Its export products include canned bonito, tuna, and mackerel, as well as fishmeal and other hydrobiologicals derived from residual material. In 2021, Transmarina's exports were valued at US$1.2 million, with 78 percent of the exports consisting of fish preparations and preserves. The destinations for these exports were Ecuador (55 percent), the United States (27 percent), Japan (15 percent), and Taiwan (3 percent).

The fishing for fish product (other than anchovies) that will be frozen is carried out by artisanal vessels that sell their catch to Transmarina. In 2021, the company invested US$500,000 in a Chinese individual quick freezing (IQF) tunnel to expand its freezing capacity and consequently its export capabilities.

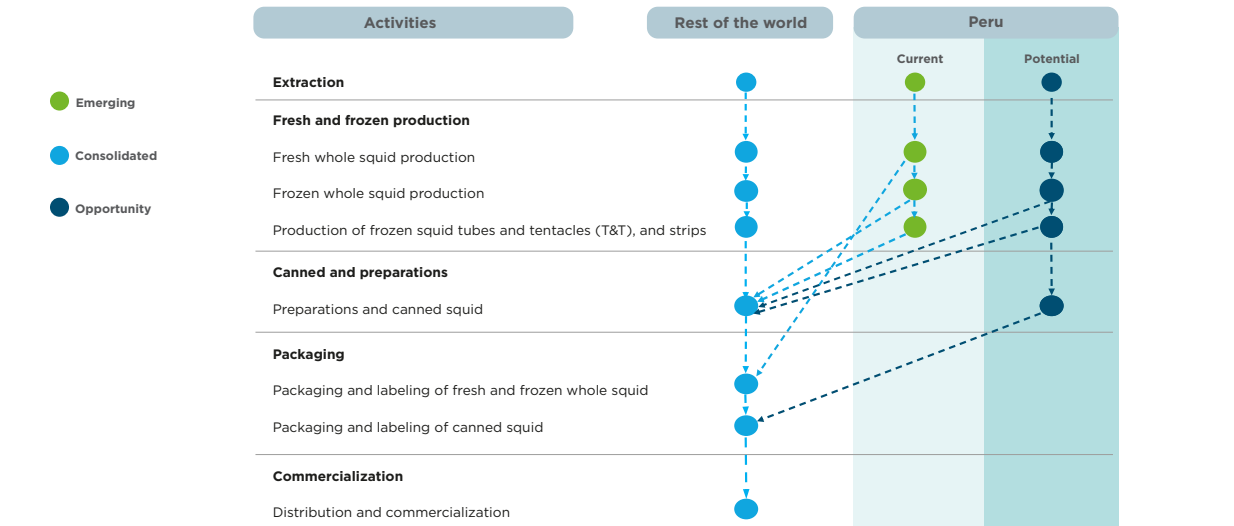
In the company's production process, machines use steam to can fish and process squid. Substituting manual labor, which is becoming scarcer due to the agro-industry boom, requires significant investment and technology in process automation. To achieve this, the company needs access to financing, although current conditions for obtaining it have become more restrictive.

Transmarina holds various quality and food safety certifications (BRC, HACCP, BASC) and in recent years it has transitioned from using liquefied petroleum gas (LPG) to natural gas, reducing costs and emissions. Additionally, the company has medium-term plans to introduce the use of solar panels. Water is sourced from wells because the company's facilities lack access to water and sewage networks, as well as to an electrical grid.

Opportunities for Transmarina include expanding its export offerings in frozen whole squid, tubes and tentacles (T&T), and other higher-value squid products. In the case of rings and tentacles, the recently acquired IQF tunnel will enable them to start exporting very shortly, as there are U.S. importers eagerly awaiting its operation to receive shipments.

In the long term, Transmarina plans to broaden its export offerings to include frozen fish species like maji maji, vacuum-sealed products, flying fish roe, and transformed roe preserves resembling caviar (in China for example a 50- to 100-gram can sells for US$20 to $25).

Illustration of potential transformation of value chains



Source: Prepared by the authors based on a review of sector information and fieldwork.

In the textiles and apparel sector, two opportunities with medium complexity have been identified that require the development of additional capabilities for production despite existing procedures. These opportunities are related to cotton fibers and involve the following products: T-shirts, sweaters, pullovers, jackets, vests, and knitted shirts. Finally, in the plastics and rubber sector, two opportunities with slightly higher complexity than those in the other two sectors were found, implying additional needs for production: polypropylene sheets and plates, and PET and high-density polyethylene preforms and caps.

In the medium term, opportunities have been identified in the fishing and textiles and apparel sectors. Unlike the opportunities mentioned above, these require processes not yet implemented by the companies, which will involve more planning, development of technological capabilities, and strengthening of production processes. This, in turn, implies a greater need for financing and the significant reduction or elimination of certain structural obstacles.[81] At the same time, the increased complexity of some of the identified products will have positive impacts on the Peruvian economy, such as strengthening productive linkages and human capital and raising the levels of innovation and knowledge and technology transfer.

In the fishing sector, five opportunities were detected: fresh scallops, frozen and canned squid, encapsulated fish oil, and animal feed from fishmeal. In the textiles and apparel sector, two opportunities related to synthetic fibers were identified: knitted shirts; and T-shirts, sweaters, pullovers, jackets, vests, and similar products (see Graph 3.8).

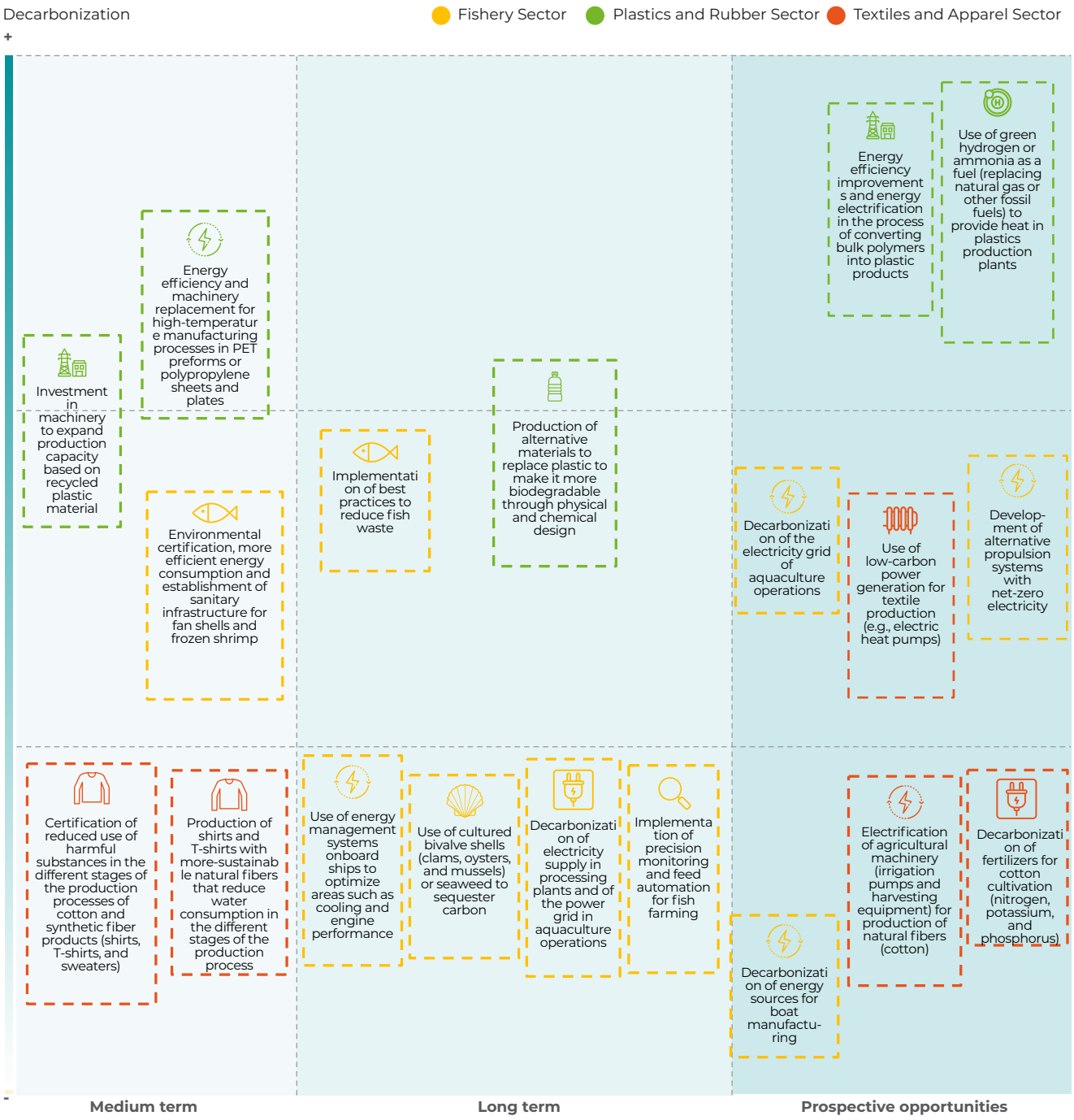
3.4.2.2 Identification of decarbonization opportunities

As mentioned earlier, decarbonization opportunities refer to specific actions that can be implemented throughout the production and marketing processes of the analyzed goods to reduce their carbon footprint. In total, 19 decarbonization opportunities were identified for Peru. Most of these are in a longer-term time horizon, and nearly half are concentrated in the fishing sector.

Graph 3.9 shows the decarbonization opportunities identified for Peru according to the associated level of decarbonization and the necessary time horizon to realize them. For the medium-term horizon, the plastics and rubber sector show two decarbonization opportunities. First, the possibility exists of increasing investment in machinery, which would enable the expansion of production capacity based on recycled plastic material. Second, there is the improvement in energy efficiency and machinery replacement for high-temperature manufacturing processes in PET products and polypropylene sheets and plates (Van Geem *et al.*, 2019; Negri & Ligthart, 2021).

81 The following section addresses the main obstacles identified. For a detailed list of obstacles, see the Annex.

Graph 3.9. Range of products identified as decarbonization opportunities in Peru



Source: Prepared by the authors based on fieldwork.

In the textiles and apparel sector, two opportunities were identified: certification for the reduced use of harmful substances in the different stages of the production processes of cotton and synthetic fiber products (such as shirts, T-shirts, and sweaters) and, on the other hand, the production of this type of products with more-sustainable natural fibers that reduce water consumption in the different stages of production (see Box 3.6).

Box 3.6. The case of cotton garments

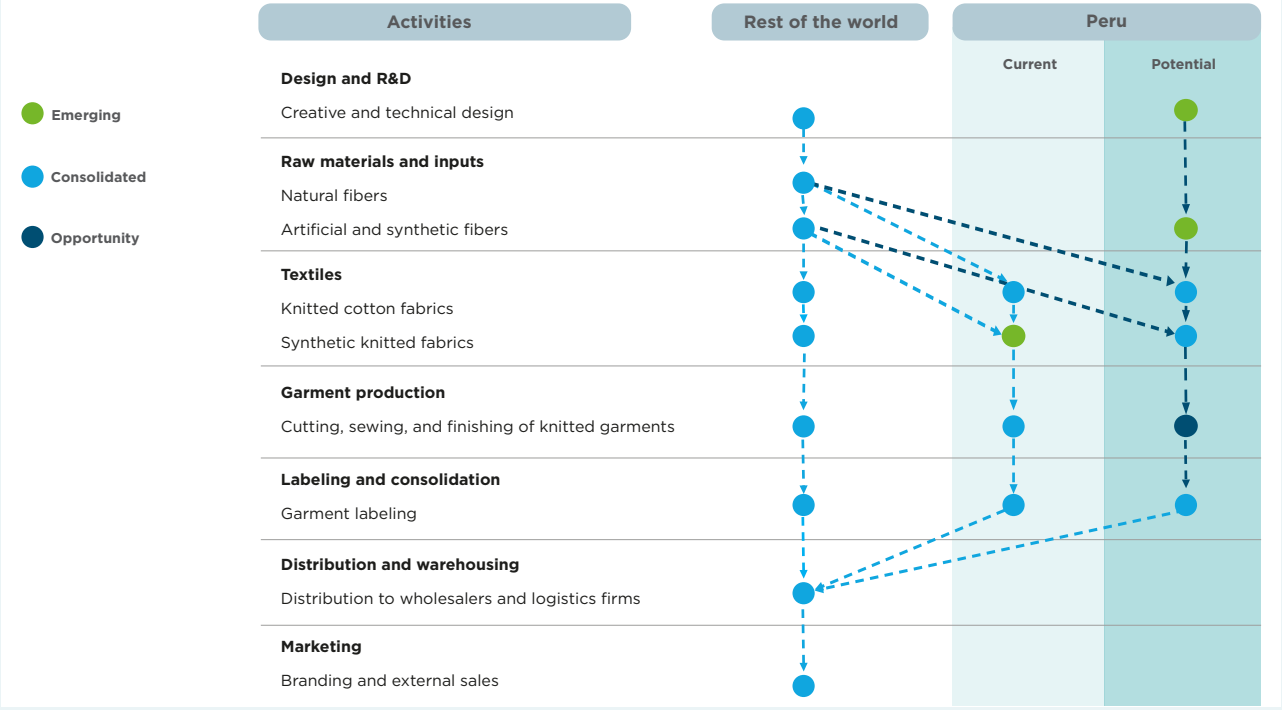
Textil Camones is a medium-sized Peruvian company founded in 1995 that exports garments to the United States, Spain, Italy, the United Kingdom, and many South American countries. It is vertically integrated for the production of a wide variety of knitted fabrics and garments and also produces garments from flat fabrics and reusable and disposable clothing for the medical sector. It also exports garments such as T-shirts, polo shirts, dresses, blouses, tanks, hoodies, jackets, cotton pants, and other types of fibers and blends such as viscose, modal, cotton modal, and polyester.

Committed to sustainable growth, the company has recently started producing garments with blends of cotton and lyocell cellulose fibers, which reduce cotton usage and water consumption. It also uses natural dyes to reduce the use of chemical dyes.

The company has expansion plans, with the construction of a spinning plant expected to begin in 2023 (once the purchased machines are available) that is estimated to cost approximately US$45 million. With this investment, the expansion of its production capacity is anticipated to achieve greater internalization and become an integrated textile transnational in three stages. The goal is to produce sustainable yarns using natural fibers and reusable products.

The first batches of sustainable yarn are expected to be produced by mid-2024. It is anticipated that by 2025, production will satisfy a portion of its fiber consumption. Additionally, the company aims to strengthen its participation in GVCs by expanding exports to the U.S. market. Currently, the United States is the destination for 20 percent of the company's exports; the goal is to increase that proportion to 60 percent by 2025 along with introducing new varieties of garments.

Illustration of potential transformation of value chains



Source: Prepared by the authors based on a review of sector information and fieldwork.

Within the fishing sector, there is the possibility of obtaining environmental certifications for products such as scallops and shrimp, promoting more energy-efficient consumption.

With regard to the long-term time horizon, a total of six opportunities were identified, with five of them associated with the fishing sector: the implementation of monitoring and automation to prevent waste in aquaculture (using cameras, sensors, and artificial intelligence to optimize the quantity and timing of food release), the use of carbon sinks in aquaculture (through clam, mussel, and oyster shells or seaweed), the use of onboard energy management systems to optimize areas such as refrigeration and engine performance, decarbonization of electricity supply in fish processing plants,[82] and the implementation of best practices for reducing fish waste.

The plastics and rubber sector has an opportunity within this time horizon. This opportunity lies in the possibility of producing substitute variants of plastic to make it more biodegradable. This would require entirely new polymer chemicals that, through physical or chemical design, make current plastics more recyclable or capable of biodegradation (Gandini, 2008; Hatti-Kaul *et al.*, 2020).

Finally, eight prospective opportunities were identified. The plastics and rubber sector has two associated opportunities. The first is improvement in energy efficiency and electrification in the process of converting bulk polymers into plastic products to reduce emissions (Van Geem *et al.*, 2019; Negri & Ligthart, 2021). Second, there is the use of green hydrogen or ammonia as a fuel to provide heat in plastic production plants, replacing natural gas or other fossil fuels.

In the textile sector, the first identified opportunity is linked to the use of low-carbon electricity generation sources for production (for example, through the use of heat pumps). Electricity supplies much of the energy needed for lighting and motors, for example, in textile plants, so decarbonization of the grid is a requirement for achieving net-zero textile manufacturing.[83] The second opportunity is the electrification of agricultural machinery (e.g., harvesting equipment) used in the production of natural fibers such as cotton. Finally, the third opportunity is the decarbonization of fertilizers used in the cultivation of such fibers.

The fishing sector has three opportunities associated with the redesign of the fishing fleet. The first is the decarbonization of energy sources in the ship-manufacturing process. The second is the development of propulsion systems powered by net-zero electricity produced by sources other than fossil fuels. Lastly, there is the decarbonization of the electrical grid for aquaculture operations.

82 Most of the processes found in a typical fish processing plant are electrical or suitable for electrification.

83 Heating requirements in textile production range from 40°C to 160°C, with the upper end of the range used for dyeing. Electric heat pumps can already supply heat in the 90°C to 150°C range, and solutions to exceed 150°C are already successfully completing demonstration projects (Arpagaus *et al.*, 2018). Thus, full electrification of textile production with decarbonized grid electricity is already a technical possibility.

4

AGENDA

4. AGENDA FOR THE SUSTAINABLE INTEGRATION INTO VALUE CHAINS IN THE ANDEAN REGION

Here we present a set of strategic priorities identified throughout the study, with the aim of promoting greater integration of the sectors studied into regional and global value chains while simultaneously advancing their decarbonization. Each of the priorities is associated with one or more critical points that are inhibiting the development of the value chain integration and decarbonization opportunities identified earlier.

4.1 Strategic priorities for moving toward greater integration in regional and global value chains

In total, five strategic priorities were identified to strengthen the regional and international integration of the analyzed value chains. The identified priorities are linked to (1) strengthening the trade support ecosystem, (2) building capacity with companies and workers, (3) strengthening local supplier networks, (4) adopting best practices for certification and access to global markets, and (5) financing to facilitate access to machinery and productive equipment. Each of these is developed below.

Strengthening the Trade Support Ecosystem

The set of institutions, infrastructure, and processes related to trade promotion and facilitation is a fundamental enabler for the international integration of productive sectors. To strengthen this ecosystem, it is necessary to invest in capabilities, platforms, and specific projects.

In terms of capabilities, it is crucial to promote the institutional strengthening of export promotion and investment attraction agencies. This will support the creation of effective mechanisms for promoting exports and the development of training programs for companies in international marketing skills, foreign-market sales management, and the use of digital sales channels for exports.

Improving customs processes is equally important to progress in this regard. For example, a review and modernization of risk management procedures at land, river, maritime, and air borders are required, aiming at integrating the different risk systems of the entities involved. At the same time, the advantages of the use of the advance declaration should be socialized with greater force, emphasizing the benefits it generates for the entry of goods. This set of measures would help to reduce the money and time spent by companies navigating customs and foreign trade operations.

At the same time, it is suggested that the implementation of systems and processes to automate and digitalize the review of merchandise and delivery of requirements for foreign trade should be prioritized.

It is important to note that these measures must be accompanied by a strengthening of the trade infrastructure in the three countries studied. To that end, it will be important to work on the development

of port logistics infrastructure and to propose regulations that promote free competition in transactions that determine the cost of cargo transportation. This would make it possible to mitigate the effects of high logistics costs, particularly those associated with freight transportation.

Building capacity with companies and workers

The lack of capabilities is identified as one of the main barriers to greater international insertion of the sectors analyzed. Beyond the lack of specific talent, this gap is also typically associated with low levels of productivity and high informality.

For example, in the case of the textiles and apparel chain, gaps were identified in the three countries studied. Improving skills within the sector could lead to higher labor productivity and fill the human capital gaps observed when analyzing performance in certain abilities, thus reducing labor informality. This will enable a higher output value to be achieved in relation to the cost of production and labor.

In the case of the automotive chain, it is essential that workers have the necessary skills to enable them to adopt special digital techniques for the competitive manufacture of auto parts and components.

To improve the quality and competitiveness of opportunities in the fishing sector and strengthen its international insertion, the first suggestion is to develop a program to promote the introduction of traceability technologies, particularly for artisanal fishing, and the development of the information systems required to certify such traceability. This will improve business capacities related to management, R&D, adoption of technological packages, and sanitary management, which are among the chain's main limitations.

In the plastics and rubber chain, investment in improving skills in the use of recycled materials for the manufacture of products that minimize and valorize solid waste and apply good production practices and technological implementation is suggested.

Five strategic priorities were identified to strengthen the regional and international insertion of the value chains analyzed, including the strengthening of the trade support ecosystem and capacity building with companies and workers.

Strengthening local supplier networks

The lack of access to adequate suppliers at competitive prices is a major obstacle to the development of the industries studied. It is essential to promote the development of local suppliers to strengthen competitiveness, with a particular focus on small and medium enterprises (SMEs).

For example, by designing and implementing lines of credit to facilitate the technification of the production processes of SMEs that can supply anchor companies, it would be possible to expand the supply of inputs.

Such cross-cutting support should be accompanied by specific interventions to help strengthen the supply networks of local and regional chains in specific sectors. For example, in the textiles and apparel chain, the need to design and implement a strategy to strengthen the supply of domestic raw materials was identified. This strategy should go hand in hand with a program to develop yarn and fabric suppliers

to increase the quality and availability of inputs that meet the necessary requirements for quality clothing.

In the automotive chain, it is necessary to put in place programs that strengthen local capabilities in Tier 2 and Tier 3 suppliers. This should include training and business advice on lean manufacturing practices, digitalization of production processes, and adoption of quality standards.

The lack of capabilities is identified as one of the main barriers to greater international insertion, associated with low levels of productivity and high informality.

Adoption of best practices for certification and access to global markets

The lack of knowledge of the technical requirements for exporting is a major barrier to integration into GVCs, particularly for SMEs. In the specific case of food and medicines, the lack of compliance with certifications and the lack of capacity to obtain permits from the U.S. Food and Drug Administration (FDA) is a major barrier to greater internationalization of the sector.

For example, in the fishing chain, it is necessary to design and implement a training and support program to adapt production standards in the harvesting and aquaculture links, with emphasis on those established by the FDA. In turn, the requirement to obtain certifications in this chain in order to access international markets makes it necessary to design and implement a training program for the adaptation of standards to update production processes, particularly those established by the FDA. This program should identify sanitary and phytosanitary measures, as well as the technical requirements demanded in foreign markets, and provide financing to support compliance.

Access to productive financing

Limited access to lines of credit in the region is one of the factors that inhibits the acquisition, for example, of the machinery and equipment needed to boost productivity and growth. In this context, it is important to design and implement support and financing programs that promote the technification of production processes, the design of new products, and the expansion of each country's production supply.

All three countries require investments to improve energy efficiency in the fisheries sector. This could address the lack of resources for improvements in farm yields, as well as the upgrading of the fishing fleet. In all cases, lack of access to credit was identified as one of the key limiting factors that prevent these investments from being undertaken.

The textiles and rubber chain is currently contending with the related problems that the supply of natural fibers is limited and cotton production faces obstacles of scale and quality. Therefore, access to financing should be supported for companies and private institutions that conduct R&D to increase their capabilities and improve their technology in order to increase cotton production yields and achieve wider dissemination of techniques and technologies to small and medium-sized producers.

Finally, in the case of the plastics and rubber sector, the promotion of guarantees and/or capital investments in strategic companies to carry out specific research and expand capacities to develop special resins for the production of inputs at national costs is contemplated. This would enable the sector to

expand and integrate more extensively in RVCs and GVCs, thus expanding the limited production capacity it currently has, given the high costs of importing raw materials.

4.2 Strategic priorities for moving toward the decarbonization of value chains

A total of five strategic priorities were identified to promote the reduction of the carbon footprint of the chains studied in the region: (1) strengthening institutional and regulatory capacities to promote decarbonization, (2) financial support for the implementation of clean energy and circular economy projects, (3) adoption of best practices for sustainability, (4) financing to facilitate access to technologies and equipment that enable decarbonization, and (5) strengthening capacities and processes for the collection and recycling of materials. Each of these is detailed below.

Strengthening institutional and regulatory capacities to drive decarbonization

To advance the decarbonization agenda, it is essential to have adequate strategic planning, as well as the necessary capacities and resources to design and implement specific policies and regulations that facilitate progress in this agenda. Despite certain advancements, significant areas for improvement remain.

For the analyzed countries, it is crucial to develop capacity-building programs for institutions to implement national strategies related to the circular economy and energy efficiency. These programs would enhance the execution capabilities of ministries and sectoral agencies and promote decentralized energy resources. The scope of these programs could strategically focus on the four chains studied where concrete opportunities were identified, which would serve as a demonstration for other sectors. For instance, designing instruments to incentivize private investment in sustainable electricity generation is proposed in order to provide the economies of the countries under study with tangible incentives for adopting technologies to increase energy efficiency, reduce GHG emissions, and enhance circularity.

The limited promotion of nonconventional renewable energy sources is, to some extent, a result of an institutional and regulatory framework that requires strengthening to promote decentralized

resources and nonconventional renewable sources (FNCER) such as photovoltaic panels, wind turbines, and biogeneration. Therefore, it will be relevant to work toward incorporating elements of the circular economy strategy and encouraging the expansion of decentralized energy resources (DER). The regulatory conditions for the extensive promotion of generation through DER are currently scant, limiting the monetization of surplus energy for investors. It is advisable to develop favorable regulations to achieve greater penetration of innovative technologies like DER.

Strengthening the regulatory strategy was identified as a crucial factor in driving the automotive chain. In Colombia and Ecuador, providing greater clarity concerning the environmental regulation roadmap for the automotive fleet and optimizing existing incentives for the replacement of vehicles with electric or hybrid technologies would result in increased investments in the manufacturing and commercialization of such vehicles.

Promotion of clean energy and the circular economy

The low availability of capital to finance circular-economy and alternative energy projects, as well as the lack of knowledge of the financial sector and its instruments, make it necessary to improve project formulation and financial structuring capabilities, thus reducing the perceived risk profiles of companies.

Various instruments can be explored to boost these projects, such as structuring and issuing thematic bonds ("green bonds") to finance decarbonization projects. Additionally, a blended finance fund of a catalytic nature could be established, with one compartment for energy efficiency and another for the circular economy, that is focused on improving the credit quality of projects. These funds could be accompanied by a facility to identify, prioritize, and structure investment projects.

It may also be advisable to promote the development of energy service companies (ESCOs) to support those companies lacking sufficient knowledge about the economic benefits of decarbonization. Additionally, these companies might lack the technical expertise, financial sophistication, or credit profiles to implement decarbonization projects. In this context, ESCOs would act as market makers in the energy efficiency or circular economy market by virtue of their technical and financial capabilities. They would invest at risk and be remunerated based on the generated savings.

Adoption of best practices for sustainability

The low technical capacity of SMEs, particularly concerning the identification, prioritization, and structuring of projects that enable the adoption of international environmental standards, advanced production techniques, clean technologies, and circular economy practices represents a significant obstacle to the decarbonization of the studied chains.[84]

It is advisable to develop a program to identify and prioritize financeable circular economy projects. This would help structure a set of low-emission business models that would serve as practical examples for SMEs.

These measures should be accompanied by specific interventions addressing the challenges of each chain in each country. For example, in the case of the fishing sector, it is crucial for companies to certify their

84 According to the latest Global Sustainable Competitiveness Index, with regard to its resource efficiency pillar—which assesses the management of resources in terms of energy, water, and raw materials—Colombia ranked 63rd out of 180 economies analyzed. This positioned Colombia well below countries in the region such as Uruguay (7), Costa Rica (14), and Panama (29) (Solability, 2021).

plants to promote exports and implement good aquaculture practices (GAP) in pools, ensuring water quality. In this regard, the implementation of a public-private coordination program that facilitates the acquisition of GAP and sustainable certifications among small and medium producers in the fishing and aquaculture sector could be beneficial.

In the textiles and apparel chain, a significant part of the challenge regarding increasing penetration in high-value markets lies in adopting sustainability practices and certifications demanded by consumers in the destination markets. This complements the existing high quality of raw materials (especially cotton in Peru), fabrics, and knitwear. In this regard, it is suggested that public-private support programs be designed and implemented for adopting production standards and acquiring sustainability certifications in textile sourcing. This responds to the low adoption of sustainability certifications such as Bluesign and other environmental standards in the sector, due to a lack of awareness of viable business models for investing in the acquisition of these certifications and low capacities to adopt them.

In total, five strategic priorities were identified to drive the reduction of the carbon footprint of the studied supply chains in the region.

Financing to facilitate access to decarbonization-enabling technologies and equipment

In addition to strengthening processes, knowledge, and capacities, progressing toward decarbonization often requires the incorporation of new technologies and equipment that can reduce the carbon footprint of the production process. These practices are not as well-known in the financial system and often have long implementation horizons, making their financing challenging.

For example, due to the requirements for freezing for exportation in the fishing sector, investments in ultra-freezing plants are necessary. However, these investments are often challenging for companies to access, due to their high costs and long amortization periods.

The fishing sector presents significant decarbonization opportunities, because its extraction and harvesting processes could greatly benefit from technological updates, machinery replacement, and the adoption of new techniques. Technological obsolescence and a lack of access to financing to improve performance or update the fishing fleet are commonly observed within the sector.

In the plastics and rubber chain, low investment in research, development, and innovation limits the adoption of cleaner technologies at the commercial forefront. This requires the implementation of investment programs in R&D projects seeking to adapt clean heat-generation technologies (such as those based on hydrogen or ammonia) to the plastic articles production link.

Strengthening capacities and processes for material collection and recycling

The combination of a lack of recycling-aligned disposal habits, low development of technical and regulatory standards, and high levels of informality in the recycling network significantly limit the utilization of recycled materials, particularly in the plastics chain.

To address this, requirements concerning processes and quality in the collection sector could be strengthened, accompanied by a capacity-building program for workers involved in recycling activities to reduce informality. These measures would help resolve some of the inefficiencies currently present in the functioning and requirements of the collection sector, which, along with the small scale of its business structure, creates distrust in the standards used in the recycling process.

Furthermore, the implementation of a plastics and rubber recycling and reuse strategy is suggested. Such a program could help strengthen requirements concerning processes and quality in the collection sector so that the technical standards required by companies demanding reusable material can be developed.

5

CONCLUSIONS

CONCLUSIONS

This document addresses the urgent need to move toward sustainable value chains in the Andean Region, focusing on Colombia, Ecuador, and Peru. Although LAC contribute just 8.1 percent to GHG emissions, this proportion has increased by 61 percent over the last three decades. Climate change threatens food security and the region's economy, with an estimated economic impact of around US$100 billion annually by 2050.

The Andean Region faces particular challenges, given that a significant proportion of its emissions is linked to exports, mainly agricultural products and fossil fuels. However, the growing global trend toward decarbonization also presents opportunities, especially in terms of integration into global and regional value chains and potential benefits in productivity, knowledge transfer, and job creation.

This study identifies key links and opportunities with high potential to strengthen regional integration and reduce carbon emissions. Importantly, the analysis reveals that all three identified countries have numerous specific links and opportunities that could simultaneously enhance value chain integration and promote a reduction in the carbon footprint. A considerable proportion of these opportunities is associated with the fishing chain, although dual-potential links and opportunities were also identified in the other studied chains.

Additionally, opportunities with specific potential to strengthen value chain insertion or drive decarbonization were identified in each of the analyzed countries. For instance, in Colombia opportunities exist in areas such as fishing harvesting, design and R&D in textiles and apparel, plastics and rubber transformation, and production and assembly in the automotive chain. Specific decarbonization opportunities, such as adopting ultra-freezing technologies in fishing and producing packages from recycled resins in plastics, were also identified.

In Ecuador, opportunities were identified in fish and fish products' extraction, preparation, and conservation; knitwear production; production and assembly of motor vehicle components; and specialized chemicals. Ecuador has dual potential for integration and decarbonization in the fishing, textiles and apparel, and plastics and rubber sectors. Within the fishing sector, electrification and fleet updating represent significant possibilities for decarbonization.

Finally, while sectors like fishing and textiles and apparel in Peru offer significant value chain insertion opportunities in the short and medium term, decarbonization emerges as a key opportunity across these sectors, focusing on more-sustainable practices, energy efficiency, and the adoption of clean technologies. Realizing these opportunities will not only benefit the environment, but also strengthen the competitiveness of the Peruvian economy.

To drive the realization of the identified opportunities, five strategic priorities for regional and international value chain integration were defined, along with five strategic priorities to promote decarbonization. The priorities related to international value chain integration include strengthening the trade support ecosystem, capacity development, strengthening local supplier networks, adopting best practices for certification, and making financing for access to machinery and equipment available. The priorities to advance decarbonization in value chains, on the other hand, are linked to strengthening institutional and regulatory capacities, providing financial support for clean energy and circular economy projects, adopting best practices for sustainability, making financing to facilitate access to decarbonization technologies and equipment available, and strengthening capacities and processes for material collection and recycling.

The strategic priorities highlight the importance of holistic policies that not only aim at improving individual aspects, such as financing or training, but also consider their interdependence. In this

regard, policy formulation must be comprehensive, with a focus on how each action contributes to the overarching goal of value chain integration and decarbonization.

Given the emphasis on capacity development, education and professional training emerge as pillars for the region for both value chain integration and decarbonization. This implies a reinforcement of educational investment specifically to align training with the current and future demands of the market and sustainability. Decarbonization is not just about reducing emissions; it involves reimagining how production and consumption occur. The Andean Region should prioritize the adoption of a circular economy model, reinforcing practices such as recycling and reuse.

International cooperation can play a crucial role in this context, for example, by facilitating access to advanced technologies and best practices for integration and decarbonization. Through bilateral or multilateral agreements, the region could benefit from the experiences of other countries that have traversed similar paths. Likewise, multilateral organizations could facilitate access to preferential financing or provide advice concerning how to structure projects that target the identified priorities. These entities could also act as independent intermediaries supporting the effort to attract direct foreign investment into key sectors.

International cooperation should be sought out not only in relation to financing or technology. Training programs that strengthen local institutions, improve governance, and ensure the effective implementation of policies are equally valuable. Regional bodies such as the Comunidad Andina de Naciones (CAN; Andean Community) and other international actors can be facilitators in promoting a common agenda for Colombia, Ecuador, and Peru. Through joint initiatives, the region can present a unified front for responding to global challenges and opportunities.

In summary, the Andean Region is at a crucial moment with regard to defining its development trajectory. It must transition to a model with a lower carbon footprint, not only because it is good for the environment, but also because it is beneficial for the economies and citizens of its countries. The identified strategic priorities offer a clear roadmap. Effective execution will depend on well-formulated policies and the ability to progress toward a shared vision that enables the building of a more prosperous and sustainable future for the countries in the region.

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ANNEX

1. METHODOLOGY

1.1. Competitiveness Analysis

Competitiveness is assessed through a rating matrix covering 10 sector-specific competitiveness factors, calculated for each link in the chain. Five of these factors—human capital; taxes, financing, and regulation; supplier availability; innovation; and market access—pertain to aspects highly specific to each link, thus warranting a unique rating for each. The remaining five factors—infrastructure, business climate, energy, natural resources, and ICT—reflect a environment not necessarily specific to these sectors but that uniformly impacts the entire economy. Therefore, their ratings tend to be consistent across links.

Table A1.1. Factors of the competitiveness matrix and subfactors evaluated in each one

Factor	1. Human Capital	2. Taxes, Financing, and Regulatory Framework	3. Supplier Availability	4. Innovation	5. Market Access	6. Infrastructure	7. Business Climate	8. Energy	9. Natural Resources	10. ICT
Evaluated elements within the factor:	Labor costs and salaries	Tax burden and fiscal incentives (exemptions)	Availability and cost of local suppliers	Technology and innovation resources and results	Access to the U.S. and LAC markets	Transportation infrastructure (WEF)	Business dynamism (WEF)	Service infrastructure (WEF)	Natural capital index (Global Sustainable Competitiveness Index)	Adoption of ICT
	Availability of skilled and competent personnel	Availability, quality, and cost of financing (credit access)	Efficiency of local suppliers		Market access	Infrastructure—Logistic Performance Index	Macroeconomic stability (WEF)			
		Specific Regulatory Framework for a Link in the Chain								

Source: Prepared by the authors.

These factors are scored on a scale of one to five, where the higher value indicates the country's leadership in competitiveness. This assessment was made on the basis of international comparative information, national and international reports, and interviews conducted by the consulting team with key stakeholders from the private and public sectors at the national level.

For factors where national or international comparative information was available, the ratings correspond to quantitative evaluations of the link's performance in the country compared to global competitor countries. For example, a rating of three reflects that the link is at the global competitiveness average, a rating of five indicates that the link is a leader in global competitiveness, and a rating of one suggests that the link lacks relevant competitive conditions.

In cases where the quantitative measurement of a factor or subfactor could not be performed due to the absence of data for the link or the country, the project's consulting team assigned scores using a qualitative assessment based on interviews with stakeholders, national reports, and expert judgment. Although this approach has limitations, "coherence testing" exercises were conducted throughout the study to ensure that the conclusions aligned with the available quantitative information. Once the competitiveness factor ratings were estimated, a weighted average was calculated to have a single index (also ranging from one to five) reflecting the competitiveness level of the link.[1]

Colombia

Table A1.2. Description of competitiveness factors in Colombia to attract foreign direct investment (FDI) that enables greater integration into GVCs and/or RVCs

Factors	Overall rating	Description
1 Human capital		Availability, cost, and quality of human talent
1.1. Labor costs	2	Since the enactment of Law 1607 of 2012, labor barriers were reduced with the elimination of parafiscal taxes for ICBF, SENA, and health for workers earning less than 10 times the minimum wage. Despite this, nonsalary labor costs in Colombia amounted to 53 percent of the net salary for formal workers, higher than the nonsalary cost in Chile (38 percent) and the Latin American average (49.5 percent) (IDB, 2017).
1.2. Availability of qualified operational personnel	2	Sixty-one percent of employers in Colombia indicate difficulties in filling job positions. While this figure is lower than in other Latin American countries such as Mexico (65 percent) and Argentina (73 percent), it highlights an imbalance between labor supply and demand in the country (Manpower Group, 2021). The positions that employers have the greatest difficulty filling are in operations and logistics, marketing and sales, administrative support, manufacturing and production, and human resources.

1 In order to test the sensitivity of the final results of the exercise to different assumptions and ways of measuring the weights, an exercise was conducted to verify that the final identification of links with integration potential was robust to three weighting methods.

Factors	Overall rating	Description
1.3. Availability of competent professional personnel	2	Colombian companies identify a workforce with inadequate education as the fourth-most recurrent obstacle to their productive development, ranking below practices of competitors in the informal sector, tax administration, and corruption (World Bank, 2017). Additionally, Colombia ranked 80th out of 141 countries in the skills pillar of the latest Global Competitiveness Index, placing well below other countries in the region such as Argentina and Chile, which ranked 31st and 47th, respectively (WEF, 2019).
1.4. Ease of hiring foreign labor	2	The participation of foreign companies in total employment in Colombia is very low compared to other Latin American countries, accounting for only 2.2 pecent, in contrast to countries like Costa Rica (32.6 percent) and the regional average (7.2 percent) (DNP, 2021). This, along with the low level of migration and its impact on the technological frontier, points up the low level of internationalization of the Colombian economy. One of the objectives of the National Council of Economic and Social Policy (CONPES 4085 of 2022) is to increase Colombia's access to global talent through a policy reform with migratory impact, incentivizing the arrival of foreigners with productive, scientific, technological, and educational vocations to the country. Monetary and nonmonetary incentives, the promotion of business internships, and the issuance of visas for internationalization have been considered for this purpose, with a short-term horizon between 2023 and 2025.
2. Taxes, Financing, and Regulation		Tax burden and fiscal incentives, stability of tax and customs rules. Availability, quality, and cost of credit. Availability and cost of inputs and capital goods from abroad necessary for production
2.1. Tax burden and fiscal incentives	2	Colombia has one of the highest corporate income tax rates in Latin America. With the amendment of Article 7 of Law 2155 of 2021 and Article 240 of the Tax Statute, the corporate income tax rate was 35 percent starting in 2022. In contrast, the average income tax rate in Latin America is 25.9 percent (CIAT, 2018). Furthermore, Colombia has one of the highest effective taxation rates in the region, with 71.2 percent of commercial profits, while in countries like Chile and Ecuador, this rate is around 34 percent (World Bank, 2019).
2.2. Availability, quality, and cost of financing	3	Colombia ranks as the third-most outstanding country in Latin America in terms of the depth of the financial system, following Chile and Panama (WEF, 2019). However, at the enterprise level, gaps in the availability and cost of financing exist, depending on the size and development stage of businesses. Financing sources tend to be very limited and costly in the initial stages and for SMEs. It is worth noting that significant steps have been taken to remove obstacles to business financing, such as Law 2069 of 2020, known as the Entrepreneurship Law, and increased coverage of financial services thanks to the adoption of technology in this sector (CPC, 2022).
2.3. Access to foreign inputs and capital goods	3	Colombia has good access to foreign inputs and capital goods. On the one hand, 53.7 percent of the total raw materials and intermediate goods imported by Colombia have a 0 percent tariff (MinCIT, 2022). Similarly, the tariff rate applied to primary products in Colombia is competitive compared to the Latin American average, with an average value of 3.5 percent versus 8.8 percent (World Bank, 2020). Additionally, the country allows for the total discount of VAT on the importation of capital goods.

Factors	Overall rating	Description
3. Availability of suppliers		Local suppliers, quality, and cost of internal and export logistics
3.1. Availability of local suppliers	3	Colombia ranked 23rd out of 137 countries in the latest World Bank Local Supplier Index (2017) with a score of 4.92 out of 7. The country surpassed the averages for both Latin America (4.11) and the world (3.96). During the COVID-19 health emergency, the national government, with support from the IDB, launched the Compra lo Nuestro platform, which aimed to support Colombian suppliers and promote the purchase of domestic products. This platform has been successful and has continued to bring benefits.
3.2. Transit times and speed of response to target markets	2	Colombia has made significant progress in customs efficiency and management. According to the Logistic Performance Index (LPI), Colombia moved from 129th among 160 countries in the 2016 customs efficiency measurement to 75th in 2018 (World Bank, 2018). This progress is largely due to the implementation of the Advanced Import Declaration. According to the measurement of processing times by the Dirección de Impuestos y Aduanas Nacionales (DIAN, National Directorate of Taxes and Customs) using the traditional mechanism, an import process takes approximately 8.6 days, while with the advanced declaration, the process takes 2.9 days. However, the number of companies using this mechanism remains low; it is estimated that in 2020, only 20 percent of importing companies used the advanced declaration (DNP, 2020).
3.3. Quality and costs of logistics services and freight	3	Colombia exhibits superior performance compared to the regional average in terms of the quality and costs of logistics services. According to the LPI, the country ranked 56th out of 160, placing it above countries like Ecuador (70th) and Peru (110th), but below Panama (35th) and Chile (43rd), the leaders in Latin America. In the International Shipments pillar of the same index, which assesses the ease of organizing shipments at competitive prices, Colombia moved from 103rd in 2016 to 46th in 2018, ranking third after Panama (34th) and Chile (38th) (World Bank, 2018). Regarding logistics costs, the National Logistics Survey (2020) indicates that the average cost for 2020 was 12.6 percent of sales, demonstrating an improvement compared to 13.5 percent in 2018. The highest logistics cost was related to transportation with a share of 30.7 percent, followed by inventories at 29.3 percent, administrative costs (17.8 percent), and storage (13.9 percent).
4. Innovation		Expenses, inputs, and results in R&D, technologies, and innovation
4.1. Resources and results in technologies and innovation	2	Gross spending on research and development (R&D) in Colombia was 0.28 percent of GDP, placing the country below the Latin American average (0.31 percent of GDP) and significantly below regional leaders like Brazil with 1.16 percent of GDP and Argentina with 0.56 percent (WIPO, 2021). The private sector has the largest share in R&D investment with a proportion of 66.2 percent, while the public sector contributes the remaining 33.8 percent. Between 2014 and 2019, the country allocated an average of 2.6 percent of the General Budget of the Nation to activities in science, technology, and innovation (STI). However, this investment has only concentrated on 6 of the existing 30 productive sectors (CPC, 2022).

Factors	Overall rating	Description
5. Market access		Local market size and availability of trade agreements with other markets and other relevant international agreements
5.1. Access to the United States and global markets	4	Colombia ranks 5th in Latin America in the number of trade agreements with 17 active agreements, trailing Chile (30), Mexico (22), Peru (20), and Panama (18). Among the extraregional trade agreements are free trade agreements (FTAs) with the United States, the European Union, and Israel (MinCIT, 2021). Exports to destinations with which Colombia currently has FTAs increased from 24.8 percent of total exports in 2005 to 70.1 percent in 2021. However, access to these markets is hindered by noncompliance with admissibility and quality measures imposed by recipient countries.
5.2. Access to regional markets	5	The country maintains trade agreements with various regional countries, such as FTAs with the CAN, Panama, Chile, Caricom, Mexico, Cuba, Mercosur, and the Pacific Alliance.
6. Infrastructure		Quality and cost of factors such as electricity and availability and quality of transport infrastructure
6.1. Availability and quality of transport infrastructure	2	Colombia ranked 92nd out of 141 countries in the transport infrastructure subpillar of the Global Competitiveness Index, placing it below countries like Panama, which ranked 48th, and Mexico at 51st (WEF, 2019). The country stands out for having strong institutional support for road infrastructure with significant private investment in road projects (CPC, 2022). While several infrastructure programs have been launched in recent years, such as Vías para la Legalidad, Colombia Rural, and Concluir, significant challenges persist in terms of the availability and quality of transport infrastructure, especially in improving tertiary roads, which represent more than 70 percent of the internal road network; however, 75 percent of these roads are in significant disrepair. On the other hand, the limited development of transport modes other than land transport affects cargo mobilization. However, recent policies such as the Intermode Master Transport Plan, CONPES (National Council of Economic and Social Policy) 3982 of 2020 establishing the National Logistics Policy, the Master Railway Plan, and the Plan to Restore the Navigability of the Magdalena River have been issued. These aim to promote the development of new transport modes and achieve greater connectivity in the country.
7. Business climate		Macroeconomic stability, legal security, absence of corruption, intellectual property protection, and ease of opening and operating businesses
7.1. Political stability and legal security	2	Colombia ranked 101st out of 141 countries in the indicator of Government Guarantee of Political Stability in the Global Competitiveness Index, placing it below countries like Chile and Uruguay, which ranked 23rd and 28th, respectively (WEF, 2019). According to the Corporación Excelencia en la Justicia (2017) (CEJ; Corporation for Excellence in Justice), legal insecurity is due to weaknesses in legal sources, obstacles to reaching a final decision in court, and the multiplicity of ordinary and extraordinary remedies that limit the efficiency of the judicial system (CEJ, 2017).

Factors	Overall rating	Description
7.2. Economic stability	5	Historically, Colombia has maintained prudent fiscal and macroeconomic management centered around an inflation-targeting regime, exchange rate flexibility, and a fiscal framework based on rules (World Bank, 2021). The country ranks fourth in the region in the macroeconomic stability pillar of the Global Competitiveness Index with a score of 90, placing it below Chile and Peru, which each scored 100 points, and Mexico with 97.8 (WEF, 2019).
7.3. Intellectual property protection	3	Colombia ranked 80th out of 132 countries in the subpillar of Knowledge Creation in the Global Innovation Index, positioning above the Latin American average but below countries like Brazil and Chile, which ranked 46th and 58th, respectively (WIPO, 2021). In 2021, the CONPES (National Council of Economic and Social Policy 4062 Document: National Intellectual Property Policy) was approved, aiming to create the enabling conditions for the creation and management of intellectual property assets. It also seeks to strengthen instruments for intellectual property protection and promote knowledge, training, and the appropriation of intellectual property (DNP, 2021).
7.4. Cultural and linguistic barriers	2	According to the IMD Competitiveness Ranking (2022), Colombia is the worst-performing country in the language skills indicator, ranking 64th out of 64 countries considered. Additionally, according to the latest English Proficiency Index, the country ranked 81st out of 112, implying limited access to other cultures due to the limited knowledge of the English language of the country's population.
8. Energy		Supply quality and cost of electricity
8.1. Quality and cost of energy	4	In recent years, Colombia has expanded its installed energy capacity through energy auctions in 2019 and significant investments in energy storage. This was reflected in an average annual increase of 2.2 percent in the effective net capacity of the National Interconnected System between 2011 and 2020 (CPC, 2022). Regarding electricity quality, according to the latest Global Competitiveness Index the country achieved a performance of 94.7 percent, placing it above the Latin American average of 86.8 percent but below Chile, which had a performance of 100 percent (WEF, 2019). It's worth noting that, in practice, six of Colombia's major cities experience constant power interruptions. The average price of energy for the industrial sector in Colombia was US$12 per kWh in 2020. This value was close to the Latin American average (US$11.2) but higher than the prices in countries like Mexico (US$11.1), Brazil (US$9.8), Peru (US$9.5), Chile (US$9.4), and Argentina (US$5.1). Additionally, the energy price in Colombia exceeded the average for OECD countries (US$6.9).
9. Natural resources		Availability of natural resources as initial endowment
9.1. Availability of natural resources	5	Colombia is a leader in the availability of natural resources. The country ranked second globally in the Natural Capital Index, which considers indicators of agriculture, biodiversity, water availability, and resources, and pollution across 160 countries (Solability, 2021).

Factors	Overall rating	Description
10. ICT		Availability, quality, and cost of telecommunications and information technologies
10.1. Internet connectivity	3	Internet coverage in Colombia is slightly above the average for Latin America, but significantly below the leading countries in the region. According to the Global Competitiveness Index (2019), fixed broadband internet subscription in Colombia was 26.9 per 100,000 inhabitants, while in countries like Uruguay and Argentina, it reached 56.7 and 38.2, respectively (WEF, 2019). Similarly, according to this index, while 62.3 percent of the adult population in Colombia used the internet, in Chile and Argentina, the figures were 82.3 and 74.3 percent, respectively (WEF, 2019).
10.2. Availability, quality, and cost of ICT services	2	In recent years, the Colombian government has initiated projects to strengthen ICT infrastructure. In 2013, the National Fiber Optic Project was implemented to expand the country's network and improve the quality of digital services. Currently, 788 municipalities in the country have benefited from this project (MinTIC, 2022). Despite these advances, the average internet speed in Colombia is lower than the Latin American average and roughly half of the average speed in OECD countries. This is because in most OECD countries, fifth-generation (5G) networks are already being deployed, while Colombia is still transitioning to fourth-generation (4G) networks (CPC, 2022).

Rating description: 1 Very lagging. 2 Lagging. 3 Moderately competitive. 4 Competitive. 5 Very competitive.

Source: Prepared by the authors based on laws, decrees, global and regional indexes, and interviews.

Competitiveness matrix of each sector

Fishery

In Table A1.3, the competitiveness matrix of the Colombian fishing chain is shown. The links related to the harvest and production of fresh and frozen products collectively exhibit the highest competitive strength, particularly in tilapia aquaculture. This is attributed to the increasing availability of suppliers in the Department of Huila; the consolidation of a group of exporting companies (including Piscícola New York, highlighted as a success case); the special conditions of temperature, oxygenation, and water quality in the Betania reservoir and adjacent ponds; the adoption of Best Aquaculture Practices (BAP) with their corresponding international certifications; and favorable conditions for export, resulting from trade agreements, especially with the United States. The U.S. market is demanding an increased volume of Colombian tilapia, in part due to the shorter distance compared to Asia and the recognition of tilapia as a good substitute for red snapper, a species under threat of extinction.

At the second level, marine extraction shows an emerging level of competitiveness, driven by the reserve of natural resources along the Caribbean and Pacific coasts. However, this link has been limited by low entrepreneurial and innovative capacity, the informal and artisanal nature of production, and only incipient market access that reflects the difficulties producers face in meeting adequate quality standards.

Also at the second level, the production of canned tuna has a moderate level of competitiveness. This is explained by the presence of companies on the Caribbean coast with qualified personnel, complementing

the offerings of Peru and Ecuador, given their proximity to Europe and the United States. However, this link still has low production capacity due to the high investment requirements for scaling up.

Table A1.3. Competitiveness matrix of the fishery chain (ratings from 1 to 5)

Chains and its segments	Factor										Weighted Total
	1. Human Capital	2. Taxes, Financing, and Regulatory Framework	3. Supplier Availability	4. Innovation	5. Market Access	6. Infrastructure	7. Business Climate	8. Energy	9. Natural Resource	10. ICT	
FISHERY	Rate between 1 and 5 (1 Very lagging, 2 Lagging, 3 Moderately competitive, 4 Competitive, 5 Very competitive										
Extraction (sea)	2	3	2	1	3	2	4	4	5	2	2.8
Harvesting (pool)	2	3	3	3	3	2	4	4	5	2	3.2
Production of fresh and frozen products	3	2	3	1	2	2	4	4	5	2	2.8
Canning and preparations	3	2	2	1	2	2	4	4	5	2	2.7
Packaging	3	2	2	1	1	2	4	4	5	2	2.3
Domestic and international marketing	2	2	2	1	1	2	4	4	5	2	2.4

High competitiveness: >3,5. At the global average: >3. Emerging competitiveness: >2,5. Low competitiveness: <2,5.

Source: Prepared by the authors based on national studies, sector reports, interviews with government entities, interviews with associations and chambers of commerce, and expert criteria.

Textiles and apparel

In Table A1.4, the competitiveness matrix of the Colombian textiles and apparel chain is shown. Although it is not a production chain with high competitiveness, the link of Design and R&D stands out, reflecting the strength of Colombian fashion and haute couture firms, both in the cases of clothing brands and independent designers.

Colombia also excels in the link corresponding to the production of garments, jeans, and intimate apparel, especially shapewear and control clothing. In this product category, Colombia is the second-largest exporter worldwide and the main supplier to the United States, thanks to the quality of raw materials and manufacturing, portfolio diversity, innovation in product design, the level of service, and the incorporation of technology in the development of differentiated products.

Table A1.4. Competitiveness matrix of the textiles and apparel chain (ratings from 1 to 5)

Chains and its segments	Factor										Weighted Total
	1. Human Capital	2. Taxes, Financing, and Regulatory Framework	3. Supplier Availability	4. Innovation	5. Market Access	6. Infrastructure	7. Business Climate	8. Energy	9. Natural Resource	10. ICT	
TEXTILES AND APPAREL	Rate between 1 and 5 (1 Very lagging, 2 Lagging, 3 Moderately competitive, 4 Competitive, 5 Very competitive										
Design and R&D	3	3	4	4	2	2	4	4	5	2	3.1
Raw materials and inputs	3	2	2	1	2	2	4	4	5	2	2.8
Textiles	2	2	2	1	2	2	4	4	5	2	2.6
Production of garments	3	2	4	1	2	2	4	4	5	2	2.7
Labeling	3	1	4	1	2	2	4	4	5	2	2.3
Distribution and storage	3	2	4	1	2	2	4	4	5	2	2.6
Domestic and international marketing	3	2	4	1	2	2	4	4	5	2	2.6

High competitiveness: >3,5. At the global average: >3. Emerging competitiveness: >2,5. Low competitiveness: <2,5.

Source: Prepared by the authors based on national studies; sector reports; interviews with representatives of government entities, associations, and chambers of commerce; and expert criteria.

In the link of raw material and input production, the country manufactures the necessary elements for the production of underwear and shapewear, which has driven the development mainly of adjacent products such as sportswear, thermal clothing, swimwear, men's clothing, and accessories.

In contrast, the links of raw material production, textiles, garments (different from underwear and shapewear), and distribution and marketing have emerging levels of competitiveness, particularly due to (1) high dependence on imported raw materials and inputs; (2) the loss of advantages derived from having local areas for the cultivation of long-fiber cotton; (3) weak adoption of best management practices, especially in manufacturing, innovation for product development, and digital marketing, as well as the certification of products and processes with international standards; (4) low market access levels in the last decade; and (5) challenges in financing and trade regulation faced by firms.

Plastics and Rubber

In Table A1.5, the competitiveness matrix of the plastics and rubber chain in Colombia is presented. The sector exhibits emerging and moderate levels of competitiveness in four out of its five links. As a country that leverages its hydrocarbon reserves, basic chemistry has been developed, enabling national and international companies to invest in various links.

Both the production of specialized chemicals and the transformation and production of plastic and rubber articles have a competitiveness level at the global average, given the presence of large international and national companies with established positions in Colombia, which, in turn, export to the United States and European Union countries.

Table A1.5. Competitiveness matrix of the plastics and rubber chain (ratings from 1 to 5)

Chains and its segments	Factor										Weighted Total
	1. Human Capital	2. Taxes, Financing, and Regulatory Framework	3. Supplier Availability	4. Innovation	5. Market Access	6. Infrastructure	7. Business Climate	8. Energy	9. Natural Resource	10. ICT	
PLASTIC AND RUBBER	Rate between 1 and 5 (1 Very lagging, 2 Lagging, 3 Moderately competitive, 4 Competitive, 5 Very competitive										
Production of primary chemical substances	3	1	2	1	1	2	4	4	5	2	2.9
Production of specialized chemicals	3	2	2	1	2	2	4	4	5	2	3.0
Transformation of plastic and rubber	3	2	3	1	2	2	4	4	5	2	3.0
Production of articles	3	3	3	3	3	2	4	4	5	2	3.0
Waste management	3	3	3	1	1	2	4	4	5	2	2.4

High competitiveness: >3,5. At the global average: >3. Emerging competitiveness: >2,5. Low competitiveness: <2,5.

Source: Prepared by the authors based on national studies; sector reports; interviews with representatives of government entities, associations, and chambers of commerce; and expert criteria.

A limiting factor for the sector's competitiveness in all links is that investment requires high levels of capital. Nevertheless, there are innovative companies, especially in the links of plastic and rubber transformation and of article production, that have successfully integrated into RVCs and GVCs.

On the other hand, the waste reuse link is characterized by limited development, despite being a link with high potential, as evidenced by the investments made by Enka, a leader in Latin America in PET recycling, which has plans to invest in a new recycling plant in the coming years.

Automotriz

Finally, in Table A1.6, the results of the competitiveness matrix of the automotive chain in Colombia can be observed. The assessment of the different links is similar: they show average values, because the low production scale of car assemblers in the country does not encourage the modernization of the sector.

Table A1.6. Competitiveness matrix of the automotive chain (ratings from 1 to 5)

Chains and its segments	Factor										Weighted Total
	1. Human Capital	2. Taxes, Financing, and Regulatory Framework	3. Supplier Availability	4. Innovation	5. Market Access	6. Infrastructure	7. Business Climate	8. Energy	9. Natural Resource	10. ICT	
AUTOMOTIVE	Rate between 1 and 5 (1 Very lagging, 2 Lagging, 3 Moderately competitive, 4 Competitive, 5 Very competitive										
Design and prototyping	3	2	2	4	2	2	4	4	5	2	2.8
Production of auto parts	3	3	3	1	2	2	4	4	5	2	2.7
Production and assembly of components	3	3	3	1	2	2	4	4	5	2	2.7
CKD units						2	4	4	5	2	
Manufacturing and assembly of vehicles	3	2	2	4	2	2	4	4	5	2	2.8
Domestic and international marketing						2	4	4	5	2	

High competitiveness: >3,5. At the global average: >3. Emerging competitiveness: >2,5. Low competitiveness: <2,5.

Source: Prepared by the authors based on national studies; sector reports; interviews with representatives of government entities, associations, and chambers of commerce; and expert criteria.

Note: Links without ratings in the Competitiveness results are due to the absence of domestic production for those links.

While the country has a series of certified companies that supply auto parts and components and also export and serve the national replacement market, the observed levels of competitiveness in the links of design and prototyping, auto parts, components, and vehicle assembly are not high. This is due to the combined effect of the aforementioned low production capacity, slow innovation processes, difficulty in providing human capital in some activities, and the limited availability of local suppliers certified according to international standards. Similarly, the recent low export orientation in the sector is reflected in low levels of market access in all links.

Finally, the automotive sector has seen notable development in the motorcycle assembly industry across all links in the chain, where Colombia, alongside Brazil, has positioned itself as a major source in Latin America and the Caribbean for this type of vehicle.

Ecuador

Table A1.7. Description of competitiveness factors in Ecuador to attract FDI for greater integration into RVCs and GVCs

Factors	Overall rating	Description
1. Human capital		Availability, cost, and quality of human talent
1.1. Labor costs	2	The nonsalary labor cost in Ecuador corresponds to 48 percent of the net salary of workers, making it one of the lowest costs in South America. It is below the average cost in Latin America (49.5 percent) (IBD, 2017). However, the denomination in dollars has reduced its competitiveness over the last decade.
1.2. Availability of qualified operational personnel	2	Annual data from the Instituto Nacional de Estadísticas y Censos (2021) (INEC; National Institute of Statistics and Censuses) shows that in Ecuador, 18 percent of the population has completed secondary education, 2 percent have nonuniversity higher education (i.e., approved nonuniversity courses), 11 percent have a university degree, and 1 percent have postgraduate education. This indicates that only 32 percent of the population has some level of education, which may align with the requirements of only certain companies, both in the sectors under study and in the rest of the Ecuadorian economy. Additionally, the high level of informality in the labor market (52 percent) and the concentration of the workforce in primary activities such as agriculture (32 percent) indicate a limited availability of qualified operational personnel.
1.3. Availability of competent professional personnel	2	According to World Bank business surveys (2017), the availability of competent professional staff is not one of the main obstacles identified by Ecuadorian entrepreneurs; only 2.2 percent of those surveyed identified the workforce's having inadequate education as their main obstacle. On another note, Ecuador ranked 76th out of 141 countries in the skills pillar of the latest Global Competitiveness Index. While the country was above the Latin American average, it was far below the leading countries in the region, namely, Argentina (31st) and Chile (47th) (WEF, 2019).
1.4. Ease of hiring foreign labor	1	In Ecuador, the participation of foreign companies in job creation is low compared to the Latin American average: while they generate 3.2 percent of total employment in the country, the average foreign company participation in the region is 7.2 percent (DNP, 2021).
2. Taxes, Financing, and Regulation		Tax burden and fiscal incentives, stability of tax and customs rules. Availability, quality, and cost of credit. Availability and cost of inputs and capital goods from abroad necessary for production
2.1. Tax burden and fiscal incentives	4	Ecuador has a corporate income tax rate of 25 percent, which is competitive compared to Latin America, as it is on par with Chile and below the Latin American average (25.9 percent) and neighboring countries such as Peru (29.5 percent) and Colombia (35 percent) (CIAT, 2018). Furthermore, Ecuador's effective tax rate stood at 34.4 percent according to the latest Doing Business report. This is low compared to Latin American countries. In Mexico and Colombia, for example, this rate exceeded 50 percent (World Bank, 2019).

Factors	Overall rating	Description
2.2. Availability, quality, and cost of financing	1	Ecuador ranked 101st out of 141 countries in the Financial System Depth subpillar of the Global Competitiveness Index. This subpillar gathers information on private sector access to domestic credit, SME financing, and market capitalization, among other aspects. In this regard, the country lags behind the Latin American average and is far behind countries like Chile and Panama, which ranked 22nd and 51st, respectively (WEF, 2019).
2.3. Access to foreign inputs and capital goods	2	The tariff rate applied to Ecuador's primary products in 2020 was high compared to the rates in other South American countries, which averaged 6.9 percent, while in countries like Peru and Chile, it was less than 2 percent. It is worth noting that Ecuador has focused on reducing primary tariffs, as in 2019, they had an average rate of 11.2 percent (World Bank, 2020).
3. Availability of suppliers		Local suppliers, quality, and cost of internal and export logistics
3.1. Availability of local suppliers	1	Ecuador ranked 97th out of 137 countries in the last World Bank Local Supplier Index (2017), indicating a lag behind the Latin American average, the global average, and some neighboring countries such as Colombia, which ranked 23rd, and Peru, which ranked at 48th.
3.2. Transit times and speed of response to target markets	3	Ecuador demonstrates outstanding customs management efficiency compared to other Latin American countries. The country ranked 48th out of 160 countries in the Customs Pillar of the LPI, making it the country in the region with the third-highest ranking after Chile and Panama, which ranked 32nd and 45th, respectively (World Bank, 2018).
3.3. Quality and costs of logistics services and freight	2	Ecuador ranked 70th out of 160 countries in the Logistics Competence pillar of the LPI (2018) with a score of 2.75 out of 5. This was above the average score for Latin America (2.61) but below the global average (2.82). Additionally, Ecuador lags significantly behind the logistics leaders in the region, namely, Panama in 35th place and Chile in 43rd. Regarding the cost of international shipments, Ecuador ranked 80th out of 160 countries, indicating a lag compared to neighboring countries Colombia and Peru, which ranked 46th and 65th, respectively (World Bank, 2018).
4. Innovation		Expenses, inputs, and results in R&D, technologies, and innovation
4.1. Resources and results in technologies and innovation	2	Ecuador's gross expenditure on research and development is approximately 0.44 percent of GDP, higher than the Latin American average of 0.31 percent, but lagging when compared to other countries in the region such as Argentina (0.56 percent) and Brazil (1.16 percent) and far behind developed countries (WIPO, 2021).
5. Market access		Local market size and availability of trade agreements with other markets and other relevant international agreements
5.1. Access to the United States and global markets	2	Ecuador has a total of 11 active trade agreements, but the majority correspond to regional agreements. The only active extraregional agreements are with the European Union, EFTA, and the United Kingdom. The country is in the process of negotiating a free trade agreement with the United States.
5.2. Access to regional markets	3	Ecuador has trade agreements with various countries in South America and Central America, including agreements with CAN, Mexico, El Salvador, Guatemala, Colombia, Peru, and Chile, among others (WTO, 2020).

Factors	Overall rating	Description
6. Infrastructure		Quality and cost of factors such as electricity and availability and quality of transport infrastructure
6.1. Availability and quality of transport infrastructure	2	Ecuador has a relatively competitive transportation infrastructure compared to other countries in Latin America, alongside Panama and Mexico. In the latest Global Competitiveness Index transportation infrastructure ranking, Ecuador ranked 64th out of 141 countries, while Panama ranked 48th and Mexico 51st (WEF, 2019).
7. Business climate		Macroeconomic stability, legal security, absence of corruption, intellectual property protection, and ease of opening and operating businesses
7.1. Political stability and legal security	1	Ecuador is one of the countries with the highest uncertainty regarding legal security, according to the Government Guarantee of Political Stability indicator of the Global Competitiveness Index (2019), ranking 127th out of 141 countries.
7.2. Economic stability	3	According to the latest Global Competitiveness Index, Ecuador's macroeconomic stability is comparable to the Latin American average with a score of 73.7 out of 100, ranking 92nd out of 141 countries. Some countries in the region, such as Peru and Chile, have the highest scores in this measurement (WEF, 2019).
7.3. Intellectual property protection	3	Ecuador's level of knowledge creation and intellectual property is very close to the Latin American average, but lags behind other countries in the region and the world. The country ranked 91st out of 132 in the Knowledge Creation subpillar of the latest Global Innovation Index (2021).
7.4. Cultural and linguistic barriers	1	Ecuador's population has very low proficiency in the English language. According to the latest English Proficiency Index, the country ranked 90th out of 112. This implies limited access to other cultures due to the scarce knowledge of this language.
8. Energy		Supply quality and cost of electricity
8.1. Quality and cost of energy	4	Ecuador ranked 89th out of 141 countries in the access to electricity ranking of the latest Global Competitiveness Index, with coverage of 97.3 percent of the population. This high coverage exceeded the Latin American average (92.8 percent) (WEF, 2019). Regarding the quality of electricity, according to the same index Ecuador scored 90.7 percent, lower than other countries in the region such as Peru (93.1 percent), Colombia (94.7 percent), and Chile (100 percent) (WEF, 2019).
9. Natural resources		Availability of natural resources as initial endowment
9.1. Availability of natural resources	4	Ecuador ranked 29th out of 180 countries in the latest Natural Capital Index, indicating good availability of natural resources. However, with regard to resource efficiency, the country ranked 91st out of 180, with its score below the Latin American average and neighboring countries Colombia and Ecuador (Solability, 2021).

Factors	Overall rating	Description
10. ICT		Availability, quality, and cost of telecommunications and information technologies
10.1. Internet connectivity	2	According to the latest Global Competitiveness Index (2019), fixed broadband internet subscriptions in Ecuador were 22.9 per 100,000 inhabitants, ranking the country 73rd out of 141 countries. Uruguay and Argentina stood out as the most outstanding countries in Latin America in this indicator, with 56.7 and 38.2 subscriptions, respectively, per 100,000 inhabitants. The proportion of the adult population using the internet in Ecuador is below the Latin American average and several reference countries. While internet users in Ecuador accounted for 57.3 percent of the adult population according to the latest Global Competitiveness Index, the average in Latin America was approximately 60.1 percent, with Argentina at 74.3 percent and Chile at 82.3 percent (WEF, 2019).
10.2. Availability, quality, and cost of ICT services	2	Access to ICT services in the country has progressed compared to previous years. In 2020, the percentage of people with an activated cell phone reached 62.9 percent, 3 percentage points higher than in 2019. Similarly, digital illiteracy in the country—those who (1) do not have an activated cell phone, (2) have not used a computer in the last 12 months, and (3) have not used the internet in the last 12 months—decreased to 10.2 percent of the population in 2020, 1.2 percentage points less than in 2019 (INEC, 2021). Despite the mentioned advances, the internet speed in the country is below the Latin American average. It ranked 11th out of 19 countries in the region in terms of median fixed internet speed (Ookla, 2022).

Rating description: 1 Very lagging. 2 Lagging. 3 Moderately competitive. 4 Competitive. 5 Very competitive.

Source: Prepared by the authors based on laws, decrees, global and regional indexes, and interviews.

Competitiveness matrix of each sector

Fishery

Table A1.8 shows the competitiveness matrix of the fishing and aquaculture chain in Ecuador. Both the extraction and harvest link, as well as the production of fresh and frozen products and their preserves link, are links that exhibit significant competitive strength in the country. This is attributed to the reserve of natural resources, the productive capacity of companies associated with their powerful and extensive fishing fleets, and access to markets.

Table A1.8. Competitiveness matrix of the fishery chain (ratings from 1 to 5)

Chains and its segments	Factor										Weighted Total
	1. Human Capital	2. Taxes, Financing, and Regulatory Framework	3. Supplier Availability	4. Innovation	5. Market Access	6. Infrastructure	7. Business Climate	8. Energy	9. Natural Resource	10. ICT	
FISHERY	Rate between 1 and 5 (1 Very lagging, 2 Lagging, 3 Moderately competitive, 4 Competitive, 5 Very competitive										
Extraction (sea)	4	3	4	3	5	2	3	4	4	2	3.5
Harvesting (pool)	4	3	4	4	5	2	3	4	4	2	3.7
Production of fresh and frozen products	4	3	3	3	5	2	3	4	4	2	3.5
Canning and preparations	4	3	3	3	5	2	3	4	4	2	3.5
Packaging	4	3	2	3	3	2	3	4	4	2	2.8
Domestic and international marketing	3	3	2	2	3	2	3	4	4	2	2.8

High competitiveness: >3,5. At the global average: >3. Emerging competitiveness: >2,5. Low competitiveness: <2,5.

Source: Prepared by the authors based on data and interviews from INEC, Banco Central del Ecuador (Central Bank of Ecuador), Servicio de Rentas Internas (Internal Revenue Service), Ministerio de Economía y Finanzas (Ministry of Economy and Finance), Superintendencia de Bancos (Superintendence of Banks), Organización Internacional del Trabajo (International Labour Organization), Trade Map, Foro Económico Mundial (World Economic Forum), guilds, associations, and chambers of businesses in the productive chains.

Packaging of fresh products and preserves, as well as marketing, are handled internally by the processing companies, contributing to an intermediate development within this link. Additionally, while Ecuador is a global leader in tuna and shrimp exports, the cost of labor and a lack of innovation contribute to these two links' having only a moderate potential.

Textiles and apparel

Table A1.9 presents the competitiveness matrix of the textiles and apparel chain in Ecuador. While it is not a highly competitive production chain, three links with moderate potential were identified: textile manufacturing, garment production, and marketing. The differentiating factors explaining this include the local availability of suppliers and the export performance that these links had in the past, indicating the existence of commercial networks that can be a foundation for building competitive strength.

Table A1.9. Competitiveness matrix of the textiles and apparel chain (ratings from 1 to 5)

Chains and its segments	Factor										Weighted Total
	1. Human Capital	2. Taxes, Financing, and Regulatory Framework	3. Supplier Availability	4. Innovation	5. Market Access	6. Infrastructure	7. Business Climate	8. Energy	9. Natural Resource	10. ICT	
TEXTILES AND APPAREL	Rate between 1 and 5 (1 Very lagging, 2 Lagging, 3 Moderately competitive, 4 Competitive, 5 Very competitive										
Design and R&D	1	2	1	1	1	2	3	4	4	2	1.8
Raw materials and inputs	2	2	2	1	1	2	3	4	4	2	2.3
Textiles	3	2	3	3	3	2	3	4	4	2	2.9
Production of garments	3	2	3	3	3	2	3	4	4	2	2.9
Labeling	3	2	2	2	2	2	3	4	4	2	2.4
Distribution and storage	2	2	2	2	2	2	3	4	4	2	2.3
Domestic and international marketing	3	2	3	2	2	2	3	4	4	2	2.5

High competitiveness: >3,5. At the global average: >3. Emerging competitiveness: >2,5. Low competitiveness: <2,5.

Source: Prepared by the authors based on data and interviews from INEC, Banco Central del Ecuador (Central Bank of Ecuador), Servicio de Rentas Internas (Internal Revenue Service), Ministerio de Economía y Finanzas (Ministry of Economy and Finance), Superintendencia de Bancos (Superintendence of Banks), Organización Internacional del Trabajo (International Labour Organization), Trade Map, Foro Económico Mundial (World Economic Forum), guilds, associations, and chambers of businesses in the productive chains.

On the other hand, design and R&D, labeling, and logistics are links that do not have significant domestic development, because they tend to depend on the brands and sales channels that govern the GVCs in international markets.

Plastics and rubber

In the plastics and rubber chain, a lower level of competitiveness was observed. Despite this, both the transformation and production of plastic and rubber articles have moderate potential, because there are large international and national companies with a presence in Colombia and Peru that export to the United States and European Union countries, especially focusing on serving the construction and infrastructure sectors. In Table A1.10, the competitiveness matrix of the plastics and rubber sector in Ecuador is presented.

Table A1.10. Competitiveness matrix of the plastics and rubber chain (ratings from 1 to 5)

Chains and its segments	Factor										Weighted Total
	1. Human Capital	2. Taxes, Financing, and Regulatory Framework	3. Supplier Availability	4. Innovation	5. Market Access	6. Infrastructure	7. Business Climate	8. Energy	9. Natural Resource	10. ICT	
PLASTIC AND RUBBER	Rate between 1 and 5 (1 Very lagging, 2 Lagging, 3 Moderately competitive, 4 Competitive, 5 Very competitive										
Production of primary chemical substances	1	1	1	1	1	2	3	4	4	2	2.3
Production of specialized chemicals	1	1	1	2	1	2	3	4	4	2	2.4
Transformation of plastic and rubber	2	2	2	2	3	2	3	4	4	2	2.8
Production of articles	2	2	3	2	3	2	3	4	4	2	2.8
Waste management	2	1	1	1	1	2	3	4	4	2	1.9

High competitiveness: >3,5. At the global average: >3. Emerging competitiveness: >2,5. Low competitiveness: <2,5.

Source: Prepared by the authors based on data and interviews from INEC, Banco Central del Ecuador (Central Bank of Ecuador), Servicio de Rentas Internas (Internal Revenue Service), Ministerio de Economía y Finanzas (Ministry of Economy and Finance), Superintendencia de Bancos (Superintendence of Banks), Organización Internacional del Trabajo (International Labour Organization), Trade Map, Foro Económico Mundial (World Economic Forum), guilds, associations, and chambers of businesses in the productive chains.

In contrast to these links, there are other upstream and downstream activities that present shortcomings placing them at low competitiveness levels, such as the production of primary chemicals and specialized chemicals, for which the country depends on imports of inputs and raw materials despite having a relevant oil and gas sector. Likewise, the existence of technologically outdated machinery and facilities and failures in waste treatment processes have left companies in the sector lagging behind and have prevented the emergence of a more sustainable material reuse link.

Automotive

Table A1.11 shows the results of the competitiveness matrix of Ecuador's automotive chain. It is an industry that faces protectionism with regard to both assembly and imports at various links in the sector. The government has the central objective of supporting small auto-parts businesses, as well as the country's three assembly firms, but the latter are focused on the local market. In this sense, there is only one link identified with competitiveness at an emerging level, which is the production of auto parts, explained by the existing production capacity with certain levels of innovation in electronic products, human capital, and the availability of local suppliers.

Table A1.11. Competitiveness matrix of the automotive chain (ratings from 1 to 5)

Chains and its segments	Factor										Weighted Total
	1. Human Capital	2. Taxes, Financing, and Regulatory Framework	3. Supplier Availability	4. Innovation	5. Market Access	6. Infrastructure	7. Business Climate	8. Energy	9. Natural Resource	10. ICT	
AUTOMOTIVE	Rate between 1 and 5 (1 Very lagging, 2 Lagging, 3 Moderately competitive, 4 Competitive, 5 Very competitive										
Design and prototyping	1	1	1	1	1	2	3	4	4	2	1.8
Production of auto parts	3	2	2	2	2	2	3	4	4	2	2.5
Production and assembly of components	3	2	2	2	1	2	3	4	4	2	2.4
CKD units	1	1	1	1	1	2	3	4	4	2	2.0
Manufacturing and assembly of vehicles	2	2	2	2	1	2	3	4	4	2	2.2
Domestic and international marketing	3	1	3	2	1	2	3	4	4	2	2.2

High competitiveness: >3,5. At the global average: >3. Emerging competitiveness: >2,5. Low competitiveness: <2,5.

Source: Prepared by the authors based on data and interviews from INEC, Banco Central del Ecuador (Central Bank of Ecuador), Servicio de Rentas Internas (Internal Revenue Service), Ministerio de Economía y Finanzas (Ministry of Economy and Finance), Superintendencia de Bancos (Superintendence of Banks), Organización Internacional del Trabajo (International Labour Organization), Trade Map, Foro Económico Mundial (World Economic Forum), guilds, associations, and chambers of businesses in the productive chains.

Peru

Table A1.12. Description of competitiveness factors in Peru to attract FDI for greater integration into RVCs and GVCs

Factors	Overall rating	Description
1. Human capital		Availability, cost, and quality of human talent
1.1. Labor costs	2	The nonsalary cost of workers in Peru corresponds to 68 percent of the average salary of workers. This places it above the average nonwage cost in Latin America (49.5 percent) and close to Argentina, which has the highest value in the region at 72 percent (IBD, 2017).
1.2. Availability of qualified operational personnel	2	Sixty-seven percent of employers in Peru indicate difficulties in filling job positions. While this is a high proportion, the country is below the global average (75 percent) and the value is close to that reported by Mexico (65 percent) (Manpower Group, 2022).
1.3. Availability of competent professional personnel	2	One of the main obstacles identified by Peruvian employers is the workforce's having inadequate education. This ranked fifth, after practices of competitors in the informal sector, corruption, political instability, and labor legislation (World Bank, 2017). Additionally, Peru ranked 81 out of 141 countries in the latest Global Competitiveness Index Skills ranking with a score of 60.2 out of 100. Although this was slightly above the Latin American average (58.7), it was well below Argentina and Chile, the leaders in the region, with scores of 72.3 and 69.8, respectively (WEF, 2019).
1.4. Ease of hiring foreign labor	2	Peru ranked eighth in Latin America in the participation of Foreign Direct Investment (FDI) companies in total employment, achieving a proportion of 6 percent. This placed it below the Latin American average (7.2 percent) but above several neighboring countries, such as Ecuador (3.2 percent), Colombia (2.2 percent), and Bolivia (1.5 percent) (DNP, 2021).
2. Taxes, Financing, and Regulation		Tax burden and fiscal incentives, stability of tax and customs rules. Availability, quality, and cost of credit. Availability and cost of inputs and capital goods from abroad necessary for production
2.1. Tax burden and fiscal incentives	3	The corporate income tax in Peru is high compared to the Latin American average. Since 2017, this tax for legal entities has been 29.5 percent, while the Latin American average is 25.9 percent (CIAT, 2018). On the other hand, Peru's effective tax rate was 36.8 percent of commercial profits, lower than the Latin American average (46.6 percent) and that of some reference countries, such as Colombia (71.2 percent) and Mexico (55.1 percent) (World Bank, 2019).
2.2. Availability, quality, and cost of financing	2	Peru ranks 69 out of 141 countries in the subpillar of Depth of the financial system in the latest Global Competitiveness Index (2019), placing it very close to the Latin American average but certainly lagging behind countries like Chile (22nd) and Panama (51st).

Factors	Overall rating	Description
2.3. Access to foreign inputs and capital goods	4	The tariff rate on primary goods in Peru is one of the lowest in Latin America, averaging 0.36 percent, while the Latin American average is 8.8 percent, and those of some neighboring countries, such as Colombia and Ecuador, are 3.5 and 6.8 percent, respectively (World Bank, 2020). All capital goods are completely duty-free and the effective tariff was 0.7 percent in 2021. According to the latest Global Competitiveness Index, Peru ranked 34th out of 141 countries in the Commercial Tariffs ranking, making it one of the leaders in the region on this issue (WEF, 2019).
3. Availability of suppliers		Local suppliers, quality, and cost of internal and export logistics
3.1. Availability of local suppliers	2	Peru ranked 48th out of 137 countries in the latest World Bank Local Supplier Quantity Index (2017). This positioned it close to the Latin American average and the global average.
3.2. Transit times and speed of response to target markets	2	According to the latest LPI (2018), Peru ranked 86th out of 160 countries in customs efficiency with a score of 2.53 out of 5, indicating a deterioration from 2016, when the country ranked 63rd with a score of 2.76. This score was slightly above the Latin American average (2.47), but it lagged behind the global average (2.67) and those of Chile (3.27) and Mexico (2.77), leading countries in the region (World Bank, 2018).
3.3. Quality and costs of logistics services and freight	1	Peru is one of the South American countries with a significant lag in terms of the competitiveness and quality of logistics services. According to the LPI, Peru ranked 110th out of 160 countries in logistics competition, surpassed only by Bolivia and Venezuela, which ranked 139th and 141st, respectively (World Bank, 2018). Regarding the International Shipments ranking of the LPI, which measures the ease of countries in organizing shipments at competitive prices, Peru ranked 65th out of 160 countries, with a score above the Latin American average (World Bank, 2018).
4. Innovation		Expenses, inputs, and results in R&D, technologies, and innovation
4.1. Resources and results in technologies and innovation	1	Peru's gross expenditure on research and development is one of the lowest in the world. According to the latest Global Innovation Index, this expenditure represented only 0.13 percent of GDP, placing it 101st out of 116 countries (WIPO, 2021).
5. Market access		Local market size and availability of trade agreements with other markets and other relevant international agreements
5.1. Access to the United States and global markets	5	Currently, Peru has 18 FTAs and four trade agreements for a total of 22 active agreements. These include FTAs with the United States, the European Union, Canada, South Korea, China, and Singapore (WTO, 2020).
5.2. Access to regional markets	5	Peru has regional trade agreements with most countries in Latin America, including free trade areas with CAN and the Pacific Alliance, as well as FTAs with Chile, Mexico, and Costa Rica, among others (WTO, 2020).

Factors	Overall rating	Description
6. Infrastructure		Quality and cost of factors such as electricity and availability and quality of transport infrastructure
6.1. Availability and quality of transport infrastructure	1	Peru ranked 97th out of 141 countries in the Infrastructure of Transport subpillar of the Global Competitiveness Index. The country lags behind the Latin American average and countries in the region such as Panama, Mexico, and Ecuador (WEF, 2019). Similarly, Peru ranked 111th out of 160 countries in the infrastructure pillar of the latest LPI, well below reference countries in the region, such as Chile (34th), Panama (42nd), and Mexico (57th) (World Bank, 2018).
7. Business climate		Macroeconomic stability, legal security, absence of corruption, intellectual property protection, and ease of opening and operating businesses
7.1. Political stability and legal security	2	Peru has a favorable level of political stability compared to the Latin American average. According to the Global Competitiveness Index's ranking of government guarantee of political stability, Peru ranked 78th out of 141 countries, while neighboring countries Colombia and Ecuador ranked 101st and 127th, respectively (WEF, 2019).
7.2. Economic stability	5	Peru's performance in terms of macroeconomic stability is remarkable, as the country ranked first out of 141 countries in the Global Competitiveness Index's ranking measuring this variable (WEF, 2019).
7.3. Intellectual property protection	2	Peru ranked 82nd out of 132 countries in the Creation of Knowledge ranking of the latest Global Innovation Index with a score of 9.39 out of 100. This placed it above the average score of Latin America (7.62) but below Brazil and Chile, leading countries in the region in this respect, which obtained scores of 23 and 14.4 points, respectively (WIPO, 2021).
7.4. Cultural and linguistic barriers	2	Peru is significantly lagging in terms language skills. The country ranked 56th out of 64 countries in the language skills indicator of the World Competitiveness Index of Institute for Management Development (IMD, 2021). Additionally, according to the latest English Proficiency Index, the country ranked 56th out of 112, implying that, compared to Colombia and Ecuador, access to other cultures is better due to people's greater knowledge of the English language. However, Ecuador lags behind other countries in the region.
8. Energy		Supply quality and cost of electricity
8.1. Quality and cost of energy	4	It is estimated that 95 percent of the population in Peru has access to electricity, which implies coverage higher than the Latin American average, which was 92.8 percent according to the latest Global Competitiveness Index. However, the country's access was lower than that of Chile and Mexico, which both have 100 percent coverage (WEF, 2019). Peru's electricity quality as a proportion of performance was 93.1 percent, placing the country 67th out of 141 economies in the Quality of Electricity ranking of the Global Competitiveness Index. This positioned it above the Latin American average (86.8 percent) and countries like Ecuador (90.7 percent) and Mexico (91.2 percent) (WEF, 2019).

Factors	Overall rating	Description
9. Natural resources		Availability of natural resources as initial endowment
9.1. Availability of natural resources	4	Peru ranks 10th in the world in the Natural Capital Index, which evaluates the availability of natural resources and biodiversity in countries. However, in the resource intensity index, which measures efficiency in the use of available resources, Peru ranked 72nd out of 180 countries, slightly above the Latin American average score (Solability, 2021).
10. ICT		Availability, quality, and cost of telecommunications and information technologies
10.1. Internet connectivity	2	According to the latest Global Competitiveness Index, fixed broadband internet subscriptions in Peru were 14.7 per 100,000 inhabitants, indicating a lag compared to the Latin American average (24.1 subscriptions) and leading countries in the region, namely Uruguay with 56.7 subscriptions and Argentina with 38.2 (WEF, 2019). Similarly, while approximately 60.1 percent of the adult population in Latin America uses the internet, in Peru this proportion was 52.5 percent according to the same index (WEF, 2019).
10.2. Availability, quality, and cost of ICT services	2	According to the IMD World Competitiveness Center's 2021 Global Digital Competitiveness Index, Peru ranked at the bottom of the overall classification, specifically 57th out of 64 countries. In comparison with Pacific Alliance countries, Peru trailed behind Chile (39th) and Mexico (56th) and only outperformed Colombia (59th). According to the 2019 National Business Survey, 13.2 percent of companies nationwide have tools or ICT platforms to finalize the sales of their products or services. This proportion increased to 16.2 percent when only companies in Metropolitan Lima were considered, which represents the highest availability of ICT tools nationwide.

Rating description: 1 Very lagging. 2 Lagging. 3 Moderately competitive. 4 Competitive. 5 Very competitive.

Source: Prepared by the authors based on laws, decrees, global and regional indexes, and interviews.

Competitiveness matrix of each sector

Fishery

In Table A1.13, the competitiveness matrix of the fishing and aquaculture chain in Peru is presented. The production of fresh and frozen fish products, followed by sea extraction and canned and prepared products, are the links with the greatest strength, supported by the relative abundance of natural resources, broad and sustained market access, and the business capabilities of exporting firms, especially the larger ones. In contrast to these strengths, average and low levels in access to financing and regulatory environment and difficulties associated with the lack of specific infrastructure availability (particularly water and sanitation) reduce the competitiveness of all links, particularly the harvesting link (commonly referred to as aquaculture). It should be noted that, in the case of the fishing sector, the processing of fishmeal and fish oil has not been considered due to their being raw materials and because their input is classified as a fully exploited species.

Table A1.13. Competitiveness matrix of the fishing chain (ratings from 1 to 5)

Chains and its segments	Factor										Weighted Total
	1. Human Capital	2. Taxes, Financing, and Regulatory Framework	3. Supplier Availability	4. Innovation	5. Market Access	6. Infrastructure	7. Business Climate	8. Energy	9. Natural Resource	10. ICT	
FISHERY	Rate between 1 and 5 (1 Very lagging, 2 Lagging, 3 Moderately competitive, 4 Competitive, 5 Very competitive										
Extraction (sea)	4	3	3	4	4	1	4	4	4	2	3.3
Harvesting (pool)	4	2	3	3	3	1	4	4	4	2	3.0
Production of fresh and frozen products	4	3	3	4	4	1	4	4	4	2	3.4
Canning and preparations	4	2	4	4	4	1	4	4	4	2	3.3
Packaging	3	3	3	3	3	1	4	4	4	2	2.7
Domestic and international marketing	4	4	4	4	3	1	4	4	4	2	3.0

High competitiveness: >3,5. At the global average: >3. Emerging competitiveness: >2,5. Low competitiveness: <2,5.

Source: Prepared by the authors based on national studies; sector reports; interviews with representatives of government entities, associations, and chambers of commerce; and expert criteria.

Textiles and apparel

In Table A1.14, the competitiveness matrix of the textiles and apparel chain in Peru is shown. Overall, this chain does not have high levels of competitiveness due to low levels of innovation and capacity in companies; challenges in terms of the availability of suppliers due to limitations in the provision of inputs, such as Pima cotton; strong competition from low-cost imported garments; and limited access to financing, given the relatively fragmented and informal business structure of the sector. Nevertheless, the link of clothing production stands out, reflecting the strength that knitwear product exports have had for over a decade. On

the other hand, design and R&D, as well as labeling and consolidation, are links that do not have significant development in the country, either because they have low or nonexistent potential or because, in the case of labeling, it is a component that firms typically integrate into the garment production process.

Table A1.14. Competitiveness matrix of the textiles and apparel chain (ratings from 1 to 5)

Chains and its segments	Factor										Weighted Total
	1. Human Capital	2. Taxes, Financing, and Regulatory Framework	3. Supplier Availability	4. Innovation	5. Market Access	6. Infrastructure	7. Business Climate	8. Energy	9. Natural Resource	10. ICT	
TEXTILES AND APPAREL	Rate between 1 and 5 (1 Very lagging, 2 Lagging, 3 Moderately competitive, 4 Competitive, 5 Very competitive										
Design and R&D	4	2	1	1	1	1	4	4	4	2	2.1
Raw materials and inputs	3	1	2	1	2	1	4	4	4	2	2.6
Textiles	3	2	2	2	2	1	4	4	4	2	2.6
Production of garments	3	3	3	3	4	1	4	4	4	2	3.2
Labeling											
Distribution and storage	4	3	1	1	4	1	4	4	4	2	2.5
Domestic and international marketing	4	3	1	1	3	1	4	4	4	2	2.6

High competitiveness: >3,5. At the global average: >3. Emerging competitiveness: >2,5. Low competitiveness: <2,5.

Source: Prepared by the authors based on national studies; sector reports; interviews with representatives of government entities, associations, and chambers of commerce; and expert criteria.

Note: Links without ratings in the Competitiveness results are due to the absence of domestic production for those links.

Plastics and rubber

Table A1.15 shows the competitiveness matrix of the plastics and rubber chain in Peru. Overall, the chain presents emerging levels of competitiveness in a significant number of its links, particularly standing out in the transformation of plastics and rubber and the production of articles, due to market access and investment in innovation by large companies driven by the Single-Use Plastic Law of 2018. However, these advantages are offset by high costs of human capital and the poor availability of local suppliers, partly due to the high informality that exists in the small-scale production of household plastic items. On the other hand, the links in the production of basic and specialized chemicals do not have significant potential, due to the absence of a petrochemical industry in the country that would serve as connected local suppliers.

Table A1.15. Competitiveness matrix of the plastics and rubber chain (ratings from 1 to 5)

Chains and its segments	Factor										Weighted Total
	1. Human Capital	2. Taxes, Financing, and Regulatory Framework	3. Supplier Availability	4. Innovation	5. Market Access	6. Infrastructure	7. Business Climate	8. Energy	9. Natural Resource	10. ICT	
PLASTIC AND RUBBER	Rate between 1 and 5 (1 Very lagging, 2 Lagging, 3 Moderately competitive, 4 Competitive, 5 Very competitive										
Production of primary chemical substances	1	1	1	1	1	1	4	4	4	2	2.3
Production of specialized chemicals	2	2	1	3	2	1	4	4	4	2	2.7
Transformation of plastic and rubber	3	2	2	2	3	1	4	4	4	2	2.9
Production of articles	3	2	2	2	2	1	4	4	4	2	2.6
Waste management	3	3	3	3	2	1	4	4	4	2	2.7

High competitiveness: >3,5. At the global average: >3. Emerging competitiveness: >2,5. Low competitiveness: <2,5.

Source: Prepared by the authors based on national studies; sector reports; interviews with representatives of government entities, associations, and chambers of commerce; and expert criteria.

1.2 Trade Potential

The trade potential dimension, through the shortening of GVCs, is based on the processing of trade flow statistics and global databases from the countries studied, developed by the IDB. For links that produce goods, subheadings of the tariff code (HS code) composing the links of the four value chains studied were identified according to the mapping described above. The opportunity size represented by imports from the United States and other countries in the Americas originating from extraregional countries in those products (and, therefore, subject to GVC shortening) was calculated. This size of the opportunity was estimated using the so-called non-repeating value at stake method.[2]

Finally, the non-repeating values at stake of the products composing each link were added to obtain a trade potential amount for each link in the value chain. Cuts were established at US$1,000 million, 500 million, and more than zero to define the standardized score between 3 and 5 (keeping values of 1 for links without values at stake identified by this method).

For links not related to the production of goods but to knowledge-based services, replicating the exercise described for goods is not possible. Therefore, an aggregated analysis of the value at stake for the entire LAC region was chosen instead of a country-by-country approach. In the end, these potential export amounts were classified into ranges to standardize a rating between one and five for each link.

2 The "value at stake" for a set of products corresponds to the sum of the value of imports of those products by the target market (e.g., the United States) from its top 10 import origins outside the Western Hemisphere in 2019. Based on this measure, the "value at stake without repetition" (also known as "non-repeating value at stake") represents the value at stake prorated among countries sharing the same opportunity (i.e., the same product and horizon) to avoid repetitions.

1.3 Identification of links with high potential

Colombia

Table A1.16. Identification of links according to their potential for integration into GVCs for Colombia

Colombia	Competitiveness (1 to 5)	Foreign trade potential (1 to 5)	Potential for integration into GVCs (1 to 5)
FISHERY			
Extraction (sea)	2.8	1.0	1.9
Harvesting (pool)	3.2	3.0	3.1
Production of fresh and frozen products	2.8	3.0	2.9
Canning and preparations	2.7	3.0	2.9
Packaging	2.3	2.3	2.3
Domestic and international marketing	2.4	2.4	2.4
TEXTILES AND APPAREL			
Design and R&D	3.1	3.0	3.0
Raw materials and inputs	2.8	1.0	1.9
Textiles	2.6	4.0	3.3
Production of garments	2.7	5.0	3.9
Labeling	2.3	1.0	1.7
Distribution and storage	2.6	2.0	2.3
Domestic and international marketing	2.6	2.0	2.3
PLASTIC AND RUBBER			
Production of primary chemical substances	2.9	3.0	2.9
Production of specialized chemicals	3.0	4.0	3.5
Transformation of plastic and rubber	3.0	5.0	4.0
Production of articles	3.0	4.0	3.5
Waste management	2.4	1.0	1.7
AUTOMOTIVE			
Design and prototyping	2.8	2.0	2.4
Production of auto parts	2.7	1.0	1.8
Production and assembly of components	2.7	4.0	3.4
CKD units		1.0	1.0
Manufacturing and assembly of vehicles	2.8	4.0	3.4
Domestic and international marketing		2.0	2.0

High potential. Potential at the global average. Emerging potential. No potential.

Source: Prepared by the authors based on national studies; sector reports; interviews with representatives of government entities, associations, chambers of commerce; and expert criteria.

Note: Links without ratings in the Competitiveness results are due to the absence of domestic production for those links.

Ecuador

Table A1.17. Identification of links according to their potential for integration into GVCs for Ecuador

Ecuador	Competitiveness (1 to 5)	Foreign trade potential (1 to 5)	Potential for integration into GVCs (1 to 5)
FISHERY			
Extraction (sea)	3.5	5.0	4.3
Harvesting (pool)	3.7	5.0	4.3
Production of fresh and frozen products	3.5	5.0	4.3
Canning and preparations	3.5	4.0	3.8
Packaging	2.8	1.0	1.9
Domestic and international marketing	2.8	2.0	2.4
TEXTILES AND APPAREL			
Design and R&D	1.8	3.0	2.4
Raw materials and inputs	2.3	4.0	3.1
Textiles	2.9	4.0	3.4
Production of garments	2.9	4.0	3.4
Labeling	2.4	1.0	1.7
Distribution and storage	2.3	2.0	2.2
Domestic and international marketing	2.5	2.0	2.2
PLASTIC AND RUBBER			
Production of primary chemical substances	2.3	1.0	1.7
Production of specialized chemicals	2.4	3.0	2.7
Transformation of plastic and rubber	2.8	3.0	2.9
Production of articles	2.8	5.0	3.9
Waste management	1.9	1.0	1.5
AUTOMOTIVE			
Design and prototyping	1.8	2.0	1.9
Production of auto parts	2.5	1.0	1.8
Production and assembly of components	2.4	3.0	2.7
CKD units	2.0	1.0	1.5
Manufacturing and assembly of vehicles	2.2	3.0	2.6
Domestic and international marketing	2.2	2.0	2.1

High potential. Potential at the global average. Emerging potential. No potential.

Source: Prepared by the authors based on national studies; sector reports; interviews with representatives of government entities, associations, and chambers of commerce; and expert criteria.

Note: Links without ratings in the Competitiveness results are due to the absence of domestic production for those links.

Peru

Table A1.18. Identification of links according to their potential for integration into GVCs for Peru

Peru	Competitiveness (1 to 5)	Foreign trade potential (1 to 5)	Potential for integration into GVCs (1 to 5)
FISHERY			
Extraction (sea)	3.3	4.0	3.7
Harvesting (pool)	3.0	4.0	3.5
Production of fresh and frozen products	3.4	4.0	3.7
Canning and preparations	3.3	3.0	3.2
Packaging	2.7	1.0	1.9
Domestic and international marketing	3.0	2.0	2.5
TEXTILES AND APPAREL			
Design and R&D	2.1	3.0	2.5
Raw materials and inputs	2.6	4.0	3.3
Textiles	2.6	4.0	3.3
Production of garments	3.2	4.0	3.6
Labeling		1.0	
Distribution and storage	2.5	2.0	2.3
Domestic and international marketing	2.6	2.0	2.3
PLASTIC AND RUBBER			
Production of primary chemical substances	2.3	1.0	1.6
Production of specialized chemicals	2.7	1.0	1.9
Transformation of plastic and rubber	2.9	4.0	3.5
Production of articles	2.6	4.0	3.3
Waste management	2.7	1.0	1.9

Alto Potencial. Potencial en la media global. Potencial emergente. Sin potencial.

Source: Prepared by the authors based on national studies; sector reports; interviews with representatives of government entities, associations, and chambers of commerce; and expert criteria.

Note: Links without ratings in the Competitiveness results are due to the absence of domestic production for those links.

1.4 Robustness test for link identification with potential

The identification of links with higher potential was based on a methodology that combines quantitative and qualitative assessments and utilizes assumptions about the weighting of competitiveness factors in the evaluation of this first dimension. Therefore, a set of assumption checks was carried out to ensure that the final identification of links with GVC integration potential was robust to three weighting methods applied to competitiveness factors:

- **Method 1** identifies links of high importance, to which it assigns a weighting of 2, and of low importance, to which it assigns a weighting of 0, and scales to maintain those values. This was the method used in identifying the links in the study exercise.

- **Method 2** assigns weighting values of 0, 0.5, and 1 to simplify the differences between links, scaling at the end.

- **The method with equal weights** assigns the same value to all the weights of the competitiveness factors for all the links.

As shown in Table A1.19, the identification of links with GVC integration potential (approximated by a score equal to or greater than 3) is robust to the different methods in all countries.

Table A1.19. Robustness exercise for weighting assumptions in each link

Robustness exercise for Colombia			
Chains and their segments	INTEGRATION POTENTIAL FOR EACH WEIGHTING METHOD		
	Equal weights	Method 1	Method 2
FISHERY			
Extraction (sea)	1.9	1.9	1.9
Harvesting (pool)	3.0	3.1	3.1
Production of fresh and frozen products	2.9	2.9	2.9
Canning and preparations	2.9	2.9	2.8
Packaging	2.4	2.3	2.3
Domestic and international marketing	2.4	2.4	2.4
TEXTILES AND APPAREL			
Design and R&D	3.1	3.0	3.1
Raw materials and inputs	1.8	1.9	1.9
Textiles	3.3	3.3	3.3
Production of garments	3.9	3.9	3.8
Labeling	1.9	1.7	1.7
Distribution and storage	2.5	2.3	2.3
Domestic and international marketing	2.4	2.3	2.3
PLASTIC AND RUBBER			
Production of primary chemical substances	2.7	2.9	3.0
Production of specialized chemicals	3.4	3.5	3.5
Transformation of plastic and rubber	3.9	4.0	4.0
Production of articles	3.6	3.5	3.5
Waste management	1.8	1.7	1.7
AUTOMOTIVE			
Design and prototyping	2.5	2.4	2.4
Production of auto parts	1.9	1.8	1.8
Production and assembly of components	3.4	3.4	3.4
CKD units	1.0	1.0	1.0
Manufacturing and assembly of vehicles	3.5	3.4	3.4
Domestic and international marketing	2.0	2.0	2.0

Robustness exercise for Ecuador			
Chains and their segments	INTEGRATION POTENTIAL FOR EACH WEIGHTING METHOD		
	Equal weights	Method 1	Method 2
FISHERY			
Extraction (sea)	4.2	4.3	4.3
Harvesting (pool)	4.3	4.3	4.3
Production of fresh and frozen products	4.1	4.3	4.2
Canning and preparations	3.6	3.8	3.7
Packaging	2.0	1.9	1.8
Domestic and international marketing	2.4	2.4	2.4
TEXTILES AND APPAREL			
Design and R&D	2.5	2.4	2.4
Raw materials and inputs	3.1	3.1	3.1
Textiles	3.4	3.4	3.4
Production of garments	3.4	3.4	3.4
Labeling	1.8	1.7	1.7
Distribution and storage	2.3	2.2	2.2
Domestic and international marketing	2.3	2.2	2.2
PLASTIC AND RUBBER			
Production of primary chemical substances	1.5	1.7	1.7
Production of specialized chemicals	2.6	2.7	2.7
Transformation of plastic and rubber	2.8	2.9	2.9
Production of articles	3.8	3.9	3.9
Waste management	1.6	1.5	1.5
AUTOMOTIVE			
Design and prototyping	2.0	1.9	1.9
Production of auto parts	1.8	1.8	1.8
Production and assembly of components	2.8	2.7	2.7
CKD units	1.5	1.5	1.5
Manufacturing and assembly of vehicles	2.7	2.6	2.6
Domestic and international marketing	2.2	2.1	2.1

Robustness exercise for Peru			
Chains and their segments	INTEGRATION POTENTIAL FOR EACH WEIGHTING METHOD		
	Equal weights	Method 1	Method 2
FISHERY			
Extraction (sea)	3.7	3.7	3.7
Harvesting (pool)	3.5	3.5	3.5
Production of fresh and frozen products	3.7	3.7	3.7
Canning and preparations	3.1	3.2	3.1
Packaging	2.0	1.9	1.8
Domestic and international marketing	2.7	2.5	2.5
TEXTILES AND APPAREL			
Design and R&D	2.7	2.5	2.5
Raw materials and inputs	3.2	3.3	3.3
Textiles	3.3	3.3	3.3
Production of garments	3.6	3.6	3.6
Labeling			
Distribution and storage	2.4	2.3	2.3
Domestic and international marketing	2.4	2.3	2.3
PLASTIC AND RUBBER			
Production of primary chemical substances	1.5	1.6	1.7
Production of specialized chemicals	1.8	1.9	1.9
Transformation of plastic and rubber	3.4	3.5	3.5
Production of articles	3.3	3.3	3.3
Waste management	2.0	1.9	1.9

Source: Prepared by the authors.

1.5 Identification of opportunities

To ensure the consistency of results across different countries, the identification of a GVC/RVC-strengthening opportunity must meet the following five criteria:

- It involves a product or service that is part of a GVC or RVC and with a final destination in the Americas (either North America or any country in LAC).
- It represents a shortening of the GVC or RVC, either by reducing physical distance, time-to-market, or time zone differences (via substitution of existing suppliers located outside the region or by seeking new suppliers or production sites to expand operations in the region).
- It creates value for the region, meaning it does not represent a zero-sum game for LAC (not opportunities to move already installed capacity from one country in the region to another neighboring country).
- The involved country has or can develop a well-identified value proposition to capture the opportunity at scale (beyond an individual project) over the next five years.
- The opportunity has the potential to diversify and increase the sophistication of local participation in GVCs and RVCs.

1.6 Identification of obstacles and critical points

The identification of obstacles arises from information collected in the fieldwork and is complemented by studies and available information in each country. Obstacles are classified as cross-cutting and sector-specific and the required time horizon to address them is identified. In particular, a distinction is made between short- and medium-term obstacles (understood as obstacles that can be addressed within a horizon of fewer than five years) and structural or long-term obstacles (understood as obstacles that require a horizon longer than five years to be addressed).

Within the universe of identified obstacles, priority is given to those most relevant to advancing the sustainable trade agenda. These obstacles are referred to as "critical points."

Colombia

Identification of Critical Points

The following are the barriers to GVC/RVC integration and decarbonization identified from interviews with entrepreneurs and representatives of nongovernmental organizations and public entities that hinder the realizing of trade integration opportunities in the four sectors. Additionally, transversal and sector-specific barriers considered critical points for promoting sustainable integration across the four chains analyzed in Colombia are detailed.

Critical points for promoting GVC/RVC integration

Table A1.20 presents the summary of the critical points identified for Colombia.

Table A1.20. Critical points of GVC/RVC integration for Colombia

Transversal/ sectoral type of obstacle	Time horizon	Critical points
Transversal	Short/medium term	• High incidence of nontariff barriers and limited knowledge about compliance with standards in foreign trade regulation (sanitary-phytosanitary standards, technical requirements, rules of origin, among others). • Elevated costs and time in customs and foreign trade operations in the analyzed chains. • Small and expensive financial instruments available to SMEs to increase their production and installed capacity.
Fishing	Short/medium term	• Difficulties in financing and obtaining necessary certifications from the USFDA. • The sector lacks sufficient production volume to invest in adopting fish ultra-freezing technology.
Textiles y confecciones	Corto/mediano plazo	• Dependence on imported raw materials (yarns and textiles) with high tariffs.
	Long term	• Need for more training and quality in the skills of seamstresses, logistics personnel, and commercial advisors.
Plastics and rubber	Short/medium term	• Limited capacity to expand production competitively due to high costs of importing raw materials. • Limited knowledge about commercial strategies in the U.S. market and a lack of capabilities to access markets. • High impact of energy costs for plastics and rubber companies located in the Caribbean region.
Automotive	Short/medium term	• Low capacities in local Tier 2 and Tier 3 suppliers to adopt more-efficient techniques and modern technologies.
	Largo plazo	• Limited capacities and access to credit to finance modernization processes toward Euro 5 standards.

Source: Prepared by the authors based on a review of sector information and fieldwork.

Within the critical points identified for integration, three are transversal to the four chains. All of them are associated with a short- to medium-term time horizon. First, the incidence of nontariff barriers and limited knowledge about standards in foreign trade regulation are prominent.[3] Additionally, there are customs costs and delays that hinder interoperability with DIAN.[4] Lastly, there is the difficulty in accessing financing faced by SMEs in the country.[5]

3 For example, sanitary and phytosanitary standards, technical requirements, and rules of origin.

4 To achieve this, the IDB approved a loan of US$250 million aimed at promoting the digital transformation of this entity, with the purpose of strengthening its role as a revenue collector and facilitator of foreign trade (Martin & Payares, 2022).

5 Only 26.1 percent of SMEs have access to bank loans (ANIF, 2020).

Within the fishing chain, there are two critical points associated with the short and medium term. For instance, producers in the Huila cluster face challenges in financing and obtaining the USFDA certifications needed to export to the U.S. market. Another identified obstacle relates to the sector's not having sufficient production volume to make investments in ultra-freezing technologies feasible. This would make possible a shift from air to maritime transport, which is crucial for decarbonization.

In the textiles and apparel sector, two critical points were identified. The first, associated with a short- to medium-term time horizon, is the dependence on imported raw materials with high tariffs, which causes clothing items to lose competitiveness. Additionally, high tariffs in this final link reduce incentives for exporting. Specifically, over 80 percent of yarns and fabrics imported between 2010 and 2021 were subject to a tariff higher than 10 percent, and over 95 percent of clothing items imported during the same period were subject to a tariff above 15 percent (sometimes even reaching 40 percent). The second obstacle, in this case associated with a long-term time horizon, lies in the lack of skilled labor in garment production. In addition, a shortage of workers in specialized areas such as design software, customer service, and technology-focused marketing was identified.

In the plastics and rubber sector, three critical points were found with a short- to medium-term horizon. First, the high costs of importing raw materials (PET, special resins, and caprolactam) diminish Colombia's competitiveness compared to other countries and limit the expansion of its production. Second, the lack of information on how to commercially enter markets like North America limits companies' ability to establish themselves as new suppliers. Last, the cost of energy significantly affects the plastics and rubber sector: several exporting companies in the processing and production stages are located in the Caribbean region, which has the highest energy costs in the region and faces quality and supply issues.

Finally, the automotive sector faces two critical points: one in the short to medium term and another in the long term. In the first case, there is the limited adoption of modern technologies required by the sector to meet international standards. For example, there is a highlighted difficulty for suppliers in producing ABS brakes, airbags, and autonomous navigation systems. This modernization requires investments in technology and workforce skills, which can take between three to five years. In the other case, although Colombia is a leader in LAC in motorcycle assembly, the standards for the commercialization of these correspond to Euro 3. Therefore, nationally produced motorcycles can only enter markets with that standard or lower. This is due, among other issues, to the limited capacities and access to credit to finance the modernization processes needed to meet Euro 5 standards.[6] It is essential to note that achieving this advancement in quality standards requires investments not only from assemblers, but also from companies throughout the entire production chain.

Critical points for promoting decarbonization

Similar to the classification done for integration, here obstacles are also categorized into cross-cutting and sector-specific, distinguishing between those that are short and medium term (addressable within a horizon of less than five years) and those that are structural or long term (understood as obstacles that require a horizon longer than five years to be addressed).

6 The Euro 5 program replaces the Euro 4 standard that has been in effect since January 2005 and represents, comparatively, a reduction in the amount of NO_2 that can be emitted by motor vehicles to 60 milligrams per kilometer (mg/km) in gasoline engines and 180 mg/km in diesel engines.

Table A1.21. Transversal and sector-specific critical points with greater impact and feasibility for Colombia's decarbonization

Transversal/ sectoral type of obstacle	Time horizon	Critical points
Transversal	Short/medium term	• Low technical capacity of SMEs for environmental project management. • Limited availability of capital to finance circular-economy and alternative energy projects.
	Long term	• Difficulty in modernizing the automotive fleet due to high costs.
Fishing	Short/medium term	• Low technical capacity of SMEs to obtain sustainability certifications. • Lack of appropriate production techniques, comprehensive information, and access to credit for exporting in SMEs. • Insufficient production volume to make investments enabling the adoption of fish ultra-freezing technology.
Textiles and apparel	Short/medium term	• Low adoption of sustainability certifications like Bluesign and other environmental standards. • Excessive use of polyester, a lower-cost but environmentally harmful material. • Technical weakness in carrying out circular-economy-related projects.
Plastics and rubber	Short/medium term	• Low awareness in the separation and management of the reusable plastic recovery chain, both by households and the productive sector.
	Long term	• High electricity costs, particularly on the Caribbean coast.
Automotive	Short/medium term	• Lack of clarity regarding the environmental regulation roadmap for the automotive fleet and low impact of incentives for fleet modernization.
	Long term	• Absence of an electric vehicle charging network.

Source: Prepared by the authors based on a review of sector information and fieldwork.

A total of three cross-cutting critical points linked to the decarbonization of the chains were identified, two associated with a short- and medium-term time horizon and one linked to a long-term time horizon. Among the first two are the capabilities of SMEs with regard to identifying, prioritizing, and structuring projects that enable them to adopt international environmental standards, advanced production techniques, and technologies associated with the circular economy. In fact, according to the latest Global Sustainable Competitiveness Index, in its resource efficiency pillar—which measures the management of resources in terms of energy, water, and raw materials—Colombia ranked 63rd out of 180 economies analyzed, below countries in the region such as Uruguay (7th), Costa Rica (14th) and Panama (29th) (Solability, 2021). Second, insufficient financing capacity for alternative energy projects was identified as a cross-cutting critical point.

Regarding the long-term cross-cutting critical point, it is difficult for the vehicle fleet to modernize due to the high cost of CAPEX[7] in clean vehicles compared to those with internal combustion, which leads to higher GHG emissions throughout all the value chains studied (in view of the fact that 85.5 percent of total cargo is transported on roads and about 44 percent of cargo transport vehicles are over 21 years old) (DNP, 2019).

Regarding the fishing sector, there are three relevant critical points and all are associated with a short- or medium-term time horizon. Small producers have production techniques that are sometimes obsolete and information for accessing credit is often insufficient. All of this is necessary to finance the certification processes required to market products on the international market. In addition, there is a low capacity for aggregating production to achieve economies of scale, which makes it difficult to invest in the adoption of deep-freezing technology for exporting fish.

The textiles and apparel sector is associated with three critical points, all of which are short and medium term. First, there is the low level of adoption of sustainability seals such as Bluesign[8] and other environmental standards due to the lack of knowledge of business models that make it feasible to invest in this type of seals and the low capacity to adopt them. Another obstacle within the sector lies in the fact that garments make use of a significant percentage of polyester (due to its low cost and the absence of regulations limiting its use), a material that is a major source of polluting. The last critical point is the technical weakness when it comes to carrying out projects linked to the circular economy, which make it possible to manage the life cycle of garments (end to end).

Within the plastics and rubber sector, two critical points can be observed: one in the short and medium term, and the other in the long term. In the first case, the low culture of plastic waste separation by households and the poor management of the recovery chain within the production sector stand out.[9] To this is added the lack of confidence in the recycling process, due to the high level of informality in the sector. In the long term, most of the existing nonhydroelectric renewable generators are located in parts of the Colombian electrical system that are not connected to the national transmission grid, such as in the Caribbean region. Some of the key companies in the sector are located in this region.

Finally, two critical sectoral points linked to the decarbonization of the automotive chain were identified, one of which is associated with a short- and medium-term time horizon and the other with a long-term horizon. First, although the technological capacity to decarbonize most of the chain already exists, the market and regulatory incentives are not yet clear. This is the case, for example, with respect to the prospects for mass adoption of electric vehicles. Part of the reason lies in a lack of clarity about the roadmap for environmental regulation of the vehicle fleet and the low incidence of incentives for fleet modernization, resulting in low investments in the manufacturing and marketing of low-emission vehicles. Finally, in the long term the adoption of electric vehicles is limited by the absence of charging networks. For example, according to the Electromaps charging point network information platform, in 2023 there were only 191 charging points nationwide, 41 of which were concentrated in Bogota.

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7 Capital expenditure (Capex) is the spending of a company on equipment and assets, resulting in benefits that secure and measure its growth.

8 The Bluesign® standard provides an independent certification system for the textile industry that considers the entire production process with the goal of minimizing the industry's environmental impact. It also contributes to reducing production costs, enhancing competitiveness, and fostering innovation.

9 According to the Ministry of Environment and Sustainable Development (2022), the recycling and reuse rate of waste was 11.8 percent in 2019, with a projection of 13.8 percent for 2021 and 14.6 percent in 2022. Enka, a market leader in PET recycling, highlighted that this proportion is even lower due to inadequate waste separation in households.

Ecuador

Critical points for promoting integration

Table A1.22 presents the summary of the critical points identified for Ecuador

Table A1.22. Critical points of integration for Ecuador

Transversal/ sectoral type of obstacle	Time horizon	Critical points
Transversal	Short/medium term	• Insufficient positioning as an investment destination and a lack of recognition as a country brand in emerging products and sectors. • High costs and inadequate quality of logistics services at international connection nodes. • Limited access to credit lines for investing in improvements to production processes, product design, and expansion into new markets.
	Long term	• Low level of preferential access due to the limited development of trade agreements. • Need to enhance competitive pressure and invest in research, innovation, and development.
Fishing	Short/medium term	• Greater need for resources and coordination to improve the performance of shrimp farming. • Obsolescence and lack of access to financing in the fishing fleet. • Trade agreements and incentives to obtain certifications that would increase exports.
Textiles and apparel	Short/medium term	• Difficulty in accessing financing.
	Long term	• Need to improve free trade zone schemes to enhance competitiveness and attract investments.
Plastics and rubber	Short/medium term	• Difficulty in accessing credit lines for expanding installed capacity. • Underdeveloped networks and supply chains for accessing raw materials and inputs at competitive prices.
Automotive	Short/medium term	• Need to develop specific strategies and actions to position Ecuador as a supplier of electronic cards in finished products and systems
	Long term	• Limited skilled workforce with regard to automation and robotization in the battery production process.

Source: Prepared by the authors based on a review of sector information and fieldwork.

Within the critical points identified for integration, five are common to all four chains. Three of them are associated with a short- and medium-term horizon. First, there is the country's difficulty in positioning itself as an investment destination,[10] compounded by low recognition of the country brand in emerging

10 According to World Bank data, Ecuador's FDI as a percentage of GDP in 2021 (0.6 percent) was the lowest since 2017 and below the average for LAC (2.4 percent).

products and sectors. Additionally, high costs and the inadequte quality of logistics services result in poor export performance.[11] The third short-term obstacle is limited access to credit lines for investment in production processes and product development.[12]

Two transversal critical points have a long-term horizon. The first is the preferential access level of exports due to the lack of trade agreements.[13] Secondly, there is a low level of innovation and development of new products, impacting access to new markets.[14]

In the fishing chain, there are three critical points associated with the short and medium term. First, there is a lack of coordination and resources to improve the performance of shrimp farming. Additionally, there is limited access to financing for the fishing fleet, impacting the sector's productivity and raising production costs. Finally, the lack of trade agreements and access to certifications is a limiting factor with regard to increasing exports in the sector.[15]

Regarding the textiles and apparel sector, two critical points were identified. The first, associated with a short- and medium-term horizon, is the difficulty in accessing financing, which delays the purchase of new machinery and hinders the generation of efficient and innovative production lines. The second obstacle, associated with a long-term horizon, lies in the absence of free trade zone schemes to improve competitiveness and attract investments.

In the plastics and rubber sector, two critical points were found, both with a short- and medium-term horizon. In the first case, there is difficulty in accessing credit to expand installed capacity, hindering the increasing of exports. There is also a lack of development in networks and supply chains that makes it difficult to access raw materials and inputs at competitive prices.

Finally, the automotive sector faces two critical points: one in the short and medium term, which focuses on the need for specific actions to position the country as a supplier of electronic cards in finished products and systems. The second point concerns the training of the workforce in automation and robotization in the battery production process in order to expedite the expansion process and the introduction of innovative products into new markets.

11 According to the Logistics Performance Index by the World Bank (2018), Ecuador received a score of 2.88 out of 5, indicating below-average performance in areas related to the quality of logistics services, coordination of shipments at competitive prices, efficiency in customs clearance, etc.

12 High-interest rates (maximum rate) and short payment terms limit access to financing. In 2021, Ecuador had the second-lowest level of financial deepening (32 percent) in the region after Mexico (21 percent).

13 The United States is Ecuador's main destination for total exports (21 percent). Despite this, the country does not have the necessary conditions to negotiate a trade agreement that would allow it to enter products from the four sectors with preferential tariffs (reduction or elimination of tariffs), reducing its competitiveness in relation to other countries.

14 According to 2019 data, the World Economic Forum assigned Ecuador a score of 33 out of 100 for innovation capacity, placing the country below the regional average (34.3).

15 In 2021, only 25 percent of shrimp exports were destined for the United States, while 43 percent went to China.

Critical points to promote decarbonization

Table A1.23. Transversal and sector-specific critical points with greater impact and feasibility for Ecuador's decarbonization

Transversal/ sectoral type of obstacle	Time horizon	Critical points
Transversal	Short/medium term	• Low capacities on the part of public entities for the execution of strategies and projects related to the circular economy and energy efficiency. • Limited technical capacity for structuring projects related to clean technologies. • Lack of resources to finance circular-economy and energy efficiency projects.
	Long term	• Greater regulatory clarity for the promotion of innovative technologies for generation with FNCER.
Fishing	Short/medium term	• Technological obsolescence and limited access to financing to improve the performance of shrimp farming or renew the fishing fleet.
Textiles and apparel	Short/medium term	• Difficulty in coordination among chain actors and insufficient support in the bureaucratic processes for obtaining certifications accrediting sustainable processes.
Plastics and rubber	Long term	• Incompatibility between the supply and demand of recycled plastic as a raw material for plastic product manufacturing and limited knowledge of the circular economy's return. • Technical barriers in machinery hindering the transition to cleaner energies.
Automotive	Long term	• Lack of incentives to expand the portfolio of sustainable mobility vehicles.

Source: Prepared by the authors based on a review of sector information and fieldwork.

A total of four critical cross-cutting points related to the decarbonization of the chains were identified: three of them are associated with a short- and medium-term horizon, while the fourth is linked to a long-term horizon. First, there is a need to improve the capacities of public entities for the execution of strategies and projects, as well as those of sector leaders for the application of circular-economy and energy efficiency strategies. Despite the publication of the guidelines with specific strategies and actions outlined in the Circular Economy White Paper and a National Energy Efficiency Plan (2016–2035) aimed at strengthening infrastructure in energy-intensive industries, progress in these areas is still limited. Additionally, portfolios of circular-economy and alternative energy projects have not been developed and technical capacity for structuring clean technology projects is still limited. Finally, there is a low availability of financing for decarbonization projects. The Plan Nacional de Eficiencia Energética (PLANEE, National Energy Efficiency Plan) has set a goal that by 2035 80 percent of energy-intensive companies will have implemented efficiency programs with the support of ESCOs. However, progress is still in its early stages. This is partly due to the undefined structure of ESCOs in PLANEE and the fact that public instruments like the Ley Orgánica de Eficiencia Energética have not translated into public funds for energy efficiency or circularity projects that ESCOs can support.

The long-term cross-cutting critical point involves the need to improve regulatory clarity for promoting technologies with FNCER. This limitation hinders private investment in distributed energy sources that can accelerate the decarbonization of the electrical grid.

In the fishing sector, there is only one critical point associated with a short-term horizon. This refers to technological obsolescence and limited access to financing to improve the performance of shrimp farming or to update the fishing fleet. According to Asobancaria (2022), Ecuador had the second-worst level of financial deepening in the region in 2021, with a level of 32 percent.

In the textiles and apparel sector, the main obstacle is the low coordination among the chain actors and the difficulty in obtaining certifications accrediting sustainable processes. Entrepreneurs have stated that public sector management and low capacities in companies for adapting to sustainable processes limit the adoption of certifications such as OEKO-TEX, Textil Exchange, Bluesign, and Environmental Certification Punto Verde.

In the plastics and rubber sector, two long-term critical points were observed. The first highlights the lack of connection between the supply and demand for recycled plastic as a raw material for the manufacture of other plastic products, as well as the limited knowledge of the returns generated by the circular economy. The second obstacle relates to technical barriers in machinery, hindering the transition to cleaner energies.

Finally, a sectoral critical point related to the decarbonization of the automotive chain was identified, with a long-term horizon. This is the lack of incentives to expand the fleet of electric vehicles. Currently, the conditions for improving the octane rating of the fuel distributed in Ecuador are not met, discouraging and limiting the purchase of vehicles with Euro 5 or 6 standards. Additionally, there has been no widespread commercialization of electric vehicles despite the tax incentives in place.

Peru

Critical points for promoting integration

Table A1.24 presents the summary of the critical points identified for Peru

Table A1.24. Critical points of integration for Peru

Transversal/ sectoral type of obstacle	Time horizon	Critical points
Transversal	Short/medium term	• High cost of credit for SMEs. • Low quality of internal logistics services.
	Long term	• Insufficient provision of physical infrastructure.
Fishing	Short/medium term	• Need to improve access to credit for medium-sized enterprises.
	Long term	• High cost of sustainable fishing certification. • Low efficiency in energy consumption, leading to increased production costs. • Need to enhance business capabilities for management, R&D, adoption of technological packages, and sanitary management in the aquaculture link.
Textiles and apparel	Short/medium term	• Limited domestic supply of natural, artificial, and synthetic fibers. • Scale and quality obstacles.
	Long term	• High non-salary labor costs.
Plastics and rubber	Short/medium term	• Need to standardize products in target markets. • Difficulty in competing on a large scale with differentiated products.

Source: Prepared by the authors based on a review of sector information and field work.

Within the critical points identified for integration, three are common to the fishing, textiles and apparel, and plastics and rubber chains. Two of them are associated with a short- and medium-term horizon. The first is the cost of access to credit, especially for SMEs, which could hinder their growth. Additionally, there is the quality of internal logistics services. For example, 3 out of 10 logistics companies in the country face difficulties at port terminals, experiencing delays in service and high security controls.[16] In the long term, the provision of physical infrastructure (sanitation networks, transportation, electricity, and telecommunications, as well as social services such as health and education) is highlighted as a significant issue. It is estimated that the short-term (five years) infrastructure access gap is over US$30 billion, the sum required to achieve basic levels in a country with socioeconomic and geographical characteristics like those of Peru.[17]

16 According to the National Logistics Survey conducted between 2020 and 2021 by the World Bank and the Ministerio de Transportes y Comunicaciones (Ministry of Transport and Communications).

17 Under a long-term horizon (20 years), the gap would be over US$95 billion, which would enable the attainment of basic infrastructure access levels similar to more-developed countries such as those in the OECD (Ministry of Economy and Finance, 2019). In turn, CAF (2021) finds that the poor quality of road infrastructure and the consequent low speed dictated by roads result in a loss of access to external markets.

Within the fishing chain, there are four critical points, one associated with the short and medium term, and the remaining three with the long term. In the first case, there is difficulty in accessing credit, which is linked to income volatility and the informality rate. According to the Ministerio

de la Producción (Ministry of Production), at the end of 2020 only 38.5 percent of medium-sized companies dedicated to extractive fishing accessed direct credits, which is primarily explained by the vulnerability in their incomes. Regarding long-term critical points, the cost of sustainable fishing certification stands out.[18] Additionally, there are difficulties in costs due to energy consumption: the average fishmeal company relies almost exclusively (98 percent) on diesel and natural gas to power its production. Finally, there are low business capacities for carrying out technological improvements in the aquaculture link.

In the textiles and apparel sector, three critical points were identified. Two of them are associated with the short- and medium-term horizon. In the first case, there is the reduced national supply of cotton fibers, which must be complemented with imports, raising the price of the final product. Cotton in the country is by and large grown by small producers—around 20,000 families—many without property titles. According to the Ministerio de Desarrollo Agrario y Riego (Ministry of Agrarian Development and Irrigation), production decreased from 111,000 tons in 2012 to just over 17,000 in 2021.[19] This level of production is affected by certified seed controls, insufficient genetic innovation, and the prohibition against the importation of transgenic seeds. Garments must meet origin requirements to be exported to the U.S. market, and as mentioned earlier, national cotton production has been decreasing—in favor of more-profitable crops—making it difficult for Peruvian products to access that market. In the long term, it will be important to reduce nonsalary labor costs, which can represent around an additional 50 percent on top of monthly remuneration, reducing competitiveness in a sector that is labor-intensive.

Finally, in the plastics and rubber sector, two critical points were found, both with a short- and medium-term horizon. In the first case, there are capacities for product homologation in target markets, which could affect SMEs. In turn, there are difficulties within the sector with regard to competing on a large scale with differentiated products. The polymer industry is usually capital-intensive, requiring companies to accumulate enough capital to invest in technology and equipment that will in turn lead to greater economies of scale in differentiated products.

Critical points for promoting decarbonization

Here are the critical points of a transversal and sectoral nature that limit the decarbonization of the four analyzed sectors.

Just as was done for RVC/GVC integration, obstacles are classified into transversal and sectoral, distinguishing between those of short- and medium-term (if they can be addressed within a horizon of fewer than five years) and structural or long-term obstacles (understood as obstacles that require a horizon longer than five years to be addressed).

18 This certification is based on the code of conduct for responsible fishing set by the Food and Agriculture Organization of the United Nations (FAO). Having this code not only brings prestige to the adopting company, but also provides greater access to new markets or the consolidation of existing ones.

19 For more details, see https://m.inei.gob.pe/estadisticas/indice-tematico/agricultural/ for annual data from 2012–2020, and for 2021, https://cdn.www.gob.pe/uploads/document/file/2861470/Bolet%C3%ADn%20Mensual%20%22El%20Agro%20en%20Cifras%22%20-%20Diciembre%202021.pdf?v=1646143060 (p. 10).

Table A1.25. Transversal and sector-specific critical points with greater impact and feasibility for Peru's decarbonization

Transversal/ sectoral type of obstacle	Time horizon	Critical points
Transversal	Short/medium term	• Lack of clarity about concrete tools available for implementing actions related to energy efficiency and material recycling. • Absence of financing plans for strategic decarbonization projects. • Lack of awareness within the productive sector regarding the economic benefits associated with reducing carbon footprints and minimizing input wastage.
	Long term	• Absence of regulatory pathways for promoting electricity generation from FNCER.
Fishing	Short/medium term	• High costs for sustainable fishing certification.
Textiles and apparel	Short/medium term	• High costs for certifications in the textile sector to access higher-value market niches.
Plastics and rubber	Short/medium term	• High informality in waste management limits formal recycling.
	Long term	• Technical barriers hinder the transition to cleaner energies.

Source: Prepared by the authors based on a review of sector information and fieldwork.

A total of four critical cross-cutting points related to the decarbonization of the chains were identified: three are associated with a short- and medium-term time horizon and one with a long-term time horizon. First, there is a need for greater clarity regarding the tools for executing energy efficiency and material reuse plans. Second, national standards and plans, such as the Plan Nacional de Productividad y Competitividad (PNPC, National Productivity and Competitiveness Plan), which includes guidelines on waste management and clean production in the studied chains, do not have associated sources or financing plans for strategic projects. Finally, it would be beneficial for the economy to have an awareness and communication plan so that the productive sector is aware of the benefits of reducing its carbon footprint and minimizing input wastage.

The challenge of the long-term cross-cutting critical point is to put in place regulatory pathways for promoting electricity generation from innovative FNCER such as RED. This would enable business investment in distributed energy sources that would accelerate the decarbonization of the electrical grid.

In the fishing sector, there is a critical point associated with a short-term horizon that lies in the cost of sustainable fishing certifications. The capacity to obtain certification depends on the complexity of the fishery, available information, and the degree of stakeholder participation. Currently, there is low coordination capacity to obtain certification from the Marine Stewardship Council (MSC), which ensures product traceability and contributes to the better management and control of the fishery.

Within the textiles and apparel sector, the critical short-term point identified is the difficulty in obtaining certifications to access higher-value market niches. Seals like Bluesign can be expensive for formal SMEs, given the high costs of researching environmental risks and implementing mitigation measures.

Finally, within the plastics and rubber sector, two critical points can be observed, one short term and one long term. In the first case, the informality in waste management is highlighted. The second obstacle lies in technical barriers related to the machinery that enables the transition to cleaner energies.

1.7 Policy Recommendations

Below are the obstacles and critical points behind each strategic priority. Each of them is associated with a series of specific actions. Policy recommendations are classified according to their time horizon (short- and medium-term or long-term, in line with the time horizon of the identified obstacles).

Table A1.26. Recommendations for RVC/GVC integration

Strategic priority	Name of action	Critical point faced	Time horizon
Strengthening the trade support ecosystem	Training in commercial strategies to achieve greater product penetration.	Lack of knowledge about commercial strategies and insufficient skills to achieve broader access.	Short/Medium term
	Strengthening trade and investment promotion capacities at the national and subregional levels.	Lack of knowledge of foreign trade standards.	Short/Medium term
	Program for efficiency in customs procedures.	High costs and time in customs and foreign trade operations.	Short/Medium term
	Program to advance in the development of logistics infrastructure in ports and regulatory improvements for competition in transportation.	High logistics costs, particularly due to transportation costs.	Long term
	Strategy to position countries as destinations for FDI and their country brand.	Lack of positioning as an investment destination and country brand recognition.	Medium term
	Program for customs facilitation and adaptation of the ECV to improve logistics and trade performance.	High costs and low quality of logistics services in international connection nodes cause poor logistics performance.	Medium term
Strengthening the trade support ecosystem	Program to improve physical infrastructure in access to ports and related roads.	Low quality of domestic logistics services.	Long term

Strategic priority	Name of action	Critical point faced	Time horizon
Capacity building of companies and workers	Upskilling and reskilling program for technical skills in sewing, logistics, and commercial advisors with ICT competencies.	Low productivity of the sector, high informality and lack of human capital for the performance of certain skills.	Long term
	Program to adopt digital and automation techniques to manufacture auto parts and components.	Lack of skilled labor in automation and robotization in the battery production process.	Long term
	Program for the adaptation of production standards and upgrading in the fishing chain.	Lack of trade agreements and incentives to obtain certifications in the U.S. market.	Medium term
	Further research on the state of biomasses.	Lack of business capabilities for management, R&D, adoption of technological packages and sanitary management.	Long term
	Upskilling and reskilling program in recycling techniques, good production practices and plastic technologies.	The low quality of education limits the availability of trained human capital.	Medium term
Strengthening local supplier networks	Textile and apparel chain reconfiguration scheme and yarn and fabric supplier development program.	Dependence on imported raw materials and high levels of protection in the last link in the chain.	Short/Medium term
	Financing for capacity expansion and export diversification of plastics companies.	Difficulty in producing on a large-scale production, with a diversity of products.	Medium term
	Tier 2 and Tier 3 supplier development program to adopt more efficient techniques and modern technologies.	Low capacity of local Tier 2 and Tier 3 suppliers.	Short/Medium term
	Program to develop supply networks for plastics production.	Low development of networks and supply chains to access raw materials and inputs at competitive prices.	Long term
	Financing for the expansion of installed capacity to increase exports to the United States and LAC countries.	Difficulty in accessing credit lines to expand installed capacity.	Medium term

Strategic priority	Name of action	Critical point faced	Time horizon
Adoption of best practices for certification and access to global markets	Catalog of requirements for access to international markets.	Non-tariff barriers and lack of knowledge of foreign trade standards.	Short/Medium term
	Program for the adaptation of fish pond certifications before the FDA.	Lack of capacity to obtain FDA permits.	Short/Medium term
	Program for the adaptation of production standards and upgrading in the fishing chain.	Lack of trade agreements and incentives to obtain certifications in the U.S. market.	Medium term
	Strategy for adapting production standards with support and training on product homologation.	Low capacity for product homologation in destination markets.	Medium term
	Financing for the modernization to Euro 5 standard of nationally produced motorcycles.	Motorcycle manufacturers do not have the capacity or access to credit to finance the processes to meet the Euro 5 standard.	Short/Medium term
Financing to facilitate access to machinery and productive equipment	Financing for the implementation of efficient production processes in fisheries.	Lack of resources to improve the performance of shrimp farms and obsolescence of the fishing fleet.	Short term
	Financing through guarantees for medium-sized fishing companies through second-tier banks focused on machinery investments.	Difficulty in accessing credit for medium-sized fisheries and inefficiencies in energy consumption that increase production costs.	Medium term
	Improvement in scientific research on seeds for the aquaculture link.	Lack of business capacity for management, R&D, adoption of technological packages, and sanitary management.	Long term
	Seed research and improvement program for cotton crops.	The supply of natural fibers is limited and cotton production faces obstacles of scale and quality.	Medium term
	Financing through second-tier banks for investments in spinning mills.	The supply of natural, synthetic and blended fibers is limited.	Medium term
	Financing for renewal of machinery and adoption of alternative energies.	Difficulty in accessing financing delays the purchase of new machinery.	Medium term
	Program to finance regional electrical interconnection to reduce electricity costs in the Colombian Caribbean.	High energy costs.	Short/Medium term

Table A1.27. Decarbonization recommendations

Strategic priority	Name of action	Critical point faced	Time horizon
Strengthening institutional and regulatory capacities to promote decarbonization	Strengthen institutional capacities to implement national decarbonization plans and massify energy efficiency instruments in the chains studied.	Lack of targeted sectoral programs and governmental technical capacities to execute existing instruments, coupled with the lack of clarity of those responsible for the implementation of circular economy and energy efficiency strategies and the scarce promotion of decentralized energy resources.	< 5 years
	Evaluate the possibility of generating beneficial tax schemes for the implementation of energy efficiency and materials reuse projects.	Low clarity is perceived on the existence of concrete tools to execute the objectives embodied in the Supreme Decrees and the energy efficiency and material reuse plans.	< 5 years
	Deepen regulation that favors the penetration of decentralized energy resources (RED).	There are few regulatory conditions for the extensive promotion of generation through decentralized energy resources (RED), which limits the monetization of the energy surpluses of investors.	Between 5 and 15 years
	Strengthening of the Agency for Regulation and Control of Energy and Resources (ARCERNNR) and design of regulations favorable to the penetration of decentralized energy resources (RED).	Lack of regulatory clarity for the promotion of innovative generation technologies with non-conventional renewable sources (NCRFs).	Between 5 and 15 years
	Technical study on instruments for the modernization of the motor vehicle fleet.	Lack of a clear strategy for environmental regulation of the vehicle fleet and low impact on existing incentives for the replacement of vehicles with environmentally friendly technologies.	< 5 years
	Design of regulation favorable to the renewal of automobiles for electric and hybrid technologies.	Lack of incentives to expand the portfolio of vehicles with sustainable mobility.	Between 5 and 15 years

Strategic priority	Name of action	Critical point faced	Time horizon
Financial support for the implementation of clean energy and circular economy projects	Financing program for energy efficiency, electrification and circular economy projects.	Low availability of capital to finance circular economy and alternative energy projects and lack of knowledge of the financial sector and its instruments.	< 5 years
	Support and incentives for the formation of investment firms in energy services and circular economy.		< 5 years
	Technical study on instruments for the modernization of the motor vehicle fleet.	Lack of a clear strategy for environmental regulation of the vehicle fleet and low impact of existing incentives for the replacement of vehicles with environmentally friendly technologies.	< 5 years
Adoption of best practices for sustainability	Facilitating the structuring of decarbonization projects and capacity building in SMEs.	Low technical capacity of small and medium-sized companies to identify, prioritize and structure projects that allow them to adopt international environmental standards, advanced production techniques, clean technologies and circular economy.	< 5 years
	Financing strategy to increase sources of resources and increase access to them for decarbonization projects.	National standards and plans, such as the National Productivity and Competitiveness Plan (PNPC), which includes guidelines on waste management and clean production in the chains studied, do not have associated sources or plans for financing strategic projects.	< 5 years
	Public-private coordination program for the adoption of good aquaculture practices and sustainable seals in fisheries.	Sustainable fishing certifications are costly for producers and require high levels of coordination.	< 5 years
	Public-private program for adapting sustainable seals for apparel.	Low level of adoption in the sector of sustainability seals such as Bluesign and other environmental standards due to a lack of knowledge of business models that make it feasible to invest in this type of seals and the low capacity to adopt them.	< 5 years

Strategic priority	Name of action	Critical point faced	Time horizon
Adoption of best practices for sustainability	Supplier development program focused on sustainable materials.	Garments make use of a significant percentage of polyester -due to its low cost and the absence of regulations limiting its use-, a material that is highly polluting to the environment.	< 5 years
Financing to facilitate access to enabling technologies and equipment to decarbonize	Financing for aquaculture companies to acquire deep-freezing technology.	Lack of production aggregation capacity to achieve economies of scale, which makes it impossible to invest in the adoption of deep-freezing technology for fish exports.	< 5 years
	Financing for the implementation of efficient production processes in fisheries.	Technological obsolescence and lack of access to financing to improve the performance of shrimp farms or renew the fishing fleet.	< 5 years
	R&D program for the adaptation of clean technologies in the generation of high heat for plastic production.	Companies in this sector have high demand for fossil fuels, which are relatively inexpensive compared to solar panel generation and other clean technologies. Although the commercial availability of technologies based on other sources -such as hydrogen, ammonia or synthetic fuels- is expected in the medium term, the low investment in research, development and innovation to bring cleaner technologies to the commercial frontier makes their adoption difficult in the next fifteen years.	Between 5 and 15 years

Strategic priority	Name of action	Critical point faced	Time horizon
Strengthening of material collection and recycling capacities and processes	Strengthening of collection standards and implementation of the plastics and rubber recycling strategy.	Inefficiency in the operation and requirements of the collection sector, coupled with the small scale of its business structure, creates mistrust in the standards used in the recycling process.	< 5 years
	Implementation of the plastics and rubber recycling and reuse strategy.	Incompatibility between the supply and demand for recycled plastic as a raw material for plastic product manufacturing and a lack of understanding of the circular economy's returns.	Between 5 and 15 years
	Design and implementation of a strategy for the formalization of actors and capacity building for the recycling and reuse of plastics and rubber in Peruvian municipalities.	The high informality in waste management limits formal recycling.	< 5 years

Vulnerability Index

First, an income score is assigned based on the World Bank country classification system (World Bank, 2023): 1—high income, 2/3—upper-middle income, 1/3—lower-middle income, and 0—low income.

Second, for the climate ambition of export destinations, we utilize the country-level ranking assigned by an independent rating exercise that assesses climate ambition (Climate Action Tracker). The tracker evaluates various aspects of each country's climate ambition, and this analysis uses the "policies and actions" rating. Countries receive a score from the Climate Action Tracker as follows: 1—Paris Agreement compatible, 4/5—Almost sufficient, 3/5—Insufficient, 2/5—Highly insufficient, 1/5—Critically insufficient.

Finally, to determine the country-level propensity of export destinations to implement climate-related trade measures, destination countries receive a Country Risk score from 0 to 2 as follows: 1—Has imposed or proposed one or more of the climate-related trade measures analyzed in Chapter 2 (EU-27, UK, US, Canada), 1/2—Has announced it will explore the imposition of one or more of the climate-related trade measures analyzed in Chapter 2 (Australia, Japan), 0—None of the above.

Subsequently, the Climate-based Market Exposure Index is calculated for a given sector *j* as the sum of

$$100 * (I_i + CR_i + CAT_i)/3 \times value_{ij} / value_j$$

where

- *i* represents the top five export destination countries for sector *j*,
- I_i is the income score of country *i*,
- CR_i is the Country Risk score for country *i*,
- CAT_i is the Climate Action Tracker score for country i,
- $Value_{ij}$ is the value of exports to country i in sector *j*, and
- $Value_j$ is the total value of exports in sector *j* to the top five export destination countries.

This way, the index ranges from 0 (no exposure) to 100 (maximum exposure).