TECHNICAL NOTE Nº IDB-TN-2992

Assessing the Distributional Implications of Transition Policies

Eduardo Cavallo
Bridget Hoffmann
Bruna Cricci

Inter-American Development Bank
Department of Research and Chief Economist

September 2024

Assessing the Distributional Implications of Transition Policies

Eduardo Cavallo*
Bridget Hoffmann*
Bruna Cricci*

* Inter-American Development Bank

Inter-American Development Bank
Department of Research and Chief Economist

September 2024

Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Cavallo, Eduardo A.
Assessing the distributional implications of transition policies / Eduardo A. Cavallo, Bridget Hoffmann, Bruna Cricci.
p. cm. — (IDB Technical Note ; 2992)
1. Climatic changes-Economic aspects-Latin America. 2. Climatic changes-Caribbean Area. 3. Climate change mitigation-Economic aspects-Latin America. 4. Climate change mitigation-Economic aspects-Caribbean Area. 5. Carbon dioxide mitigation-Economic aspects-Latin America. 6. Carbon dioxide mitigation-Economic aspects-Caribbean aspects. 7. Income distribution-Latin America. 8. Income distribution-Caribbean Area. I. Hoffmann, Bridget. II. Cricci, Bruna. III. Inter-American Development Bank. Department of Research and Chief Economist. IV. Title. V. Series.
IDB-TN-2992

http://www.iadb.org

Abstract

Policies to transition to a low-carbon economy in Latin America and the Caribbean will have important distributional impacts. This article aims to assess how these policies affect different economic sectors and socioeconomic groups and to provide policy recommendations for increasing equity and inclusion. Many of the negative impacts that may exacerbate existing inequalities can be reduced or avoided through policies that compensate citizens for higher prices and worse employment opportunities. Furthermore, well-designed transition policies that have inclusion as an explicit goal can promote equal access to the benefits of transition policies. Governments can also take this opportunity to broadly strengthen social protection measures to support workers during concurrent labor market disruptions from automation, artificial intelligence, or other sources.

JEL classifications: D63, H23, Q20, Q28, Q38, Q48
Keywords: Low-carbon, Climate change mitigation, Transition to net zero, Inequality, Distributional impacts

1. Introduction

This article explores the distributive impacts of policies to transition to a low-carbon economy in Latin America and the Caribbean (LAC), the region with the highest level of income inequality. It aims to assess how these policies affect different economic sectors and socioeconomic groups and to provide policy recommendations for increasing equity and inclusion.

Climate change poses substantial risks to economic growth in LAC. Rising temperatures, altered precipitation patterns, and increased frequency of extreme weather events have profound economic implications. Research indicates that higher temperatures and climate variability negatively impact GDP growth, particularly in sectors such as agriculture, forestry, fishing, and energy production. The aggregate impacts of climate change often mask heterogeneous effects across sectors, locations, and groups that generally exacerbate existing inequalities. Lower-income households and countries typically face higher exposure to climate hazards and greater vulnerability, with fewer resources to cope with changes in climate.

Low-carbon transition policies that aim to reduce greenhouse gas (GHG) emissions are critical to mitigate climate change. Examples of these policies include carbon pricing, subsidies for renewable energy, and regulatory measures such as emissions quotas and land use restrictions. Low-carbon transition policies aim to promote sustainable development and, by reducing GHG emissions, they may reduce the unequal effects of climate change impacts.

Low-carbon transition policies will have economic impacts that vary across sectors, locations, and groups. For instance, policies supporting renewable energy generation can create economic opportunities in the clean energy sector while leading to job losses in the fossil fuel industry. Understanding such distributional impacts is crucial for designing effective and equitable transition policies. Well-designed policies can include compensatory measures to mitigate adverse effects on specific groups and sectors and promote social and economic fairness without compromising climate goals.

This paper provides an analysis of how transition policies affect different economic sectors and socioeconomic groups in LAC based on a comprehensive review of the literature and the available evidence. Section 2 focuses on the two principal sectors responsible for GHG emissions in the region: agriculture, forestry, and other land uses (AFOLU), and energy, which is analyzed in two parts: i) electricity generation and fossil fuel exploration, and ii) transportation. The paper discusses two broad categories of existing mitigation policies, those that aim to influence the price

of emissions through mechanisms like carbon pricing and subsidies and those that seek to change consumer and producer behavior through regulatory approaches.

Section 3 analyzes the distributive impacts of transition policies on various economic sectors, locations, and socioeconomic groups. This section details how broad economic sectors such as agriculture, industry, and market services are affected by these policies, highlighting both positive impacts, such as job creation in the renewable energy industry, and negative impacts, such as job losses in industries related to fossil fuel extraction and processing and fossil fuel power plants. The section also delves into the effects of transition policies on different socioeconomic groups, including urban and rural populations, indigenous communities, low-income households, women, and informal workers.

Finally, Section 4 outlines compensatory strategies and complementary policies. This section emphasizes the importance of integrating social and economic justice into climate mitigation strategies and highlights the need for policies that are effective in reducing emissions and in ensuring that their distribution of costs and benefits is equitable across all socioeconomic groups.

The diverse impacts of mitigation policies on economic sectors and social groups underscores the importance of inclusive and equitable low-carbon transition policies. By integrating fairness considerations into climate strategies, policymakers can achieve effective emissions mitigation while promoting equity and inclusiveness. This approach ensures that the benefits of low-carbon transitions are shared broadly, minimizing adverse impacts on vulnerable populations and supporting sustainable development in LAC.

2. Mitigation Policy Framework and Emission Sources Overview

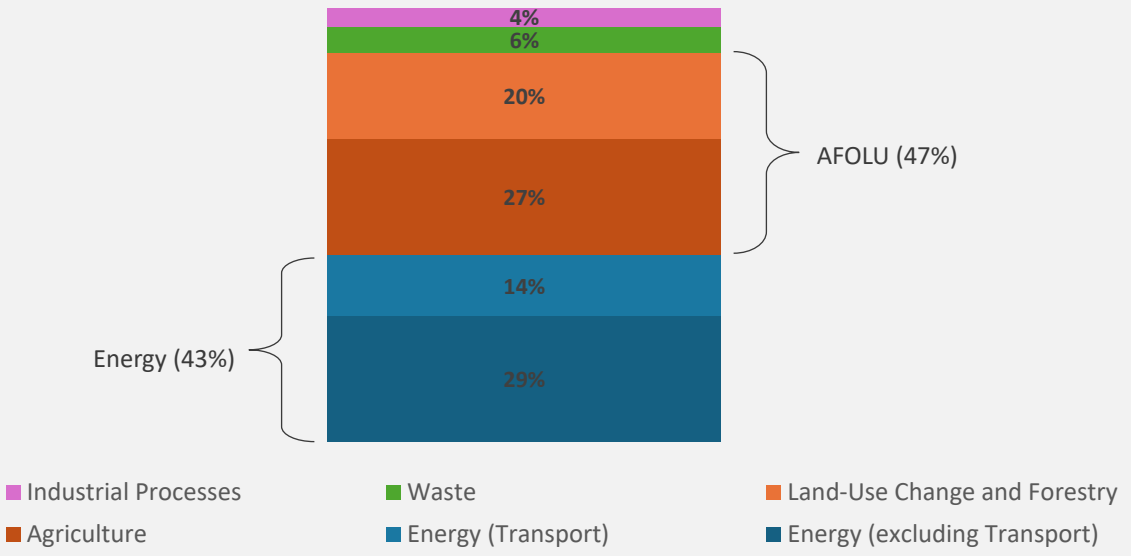
2.1 Key Sources of GHG Emissions in LAC

In Latin America and the Caribbean (LAC), GHG are predominantly emitted from two key sectors: agriculture, forestry, and other land uses (AFOLU), and energy (electricity generation, fossil fuel exploration, and transportation). The share of LAC GHGs emitted by sector is depicted in Figure 1. The AFOLU sector (disaggregated into agriculture and land-use change and forestry) contributes the greatest share of emissions, followed by energy, followed by waste management and industrial processes.

AFOLU accounts for approximately 47 percent of total GHG emissions (Climate Watch, 2021). This contribution is due to carbon-intensive agricultural practices and deforestation, which release large amounts of carbon dioxide and methane into the atmosphere (IPCC 2022).

The energy sector, including transportation, electricity generation, and fossil fuel exploration, accounts for 43 percent of emissions (Climate Watch, 2021). Of the 43 percent of emissions from the energy sector, 14 percent of emissions come from transportation.

Figure 1. Distribution of GHG Emissions by Sector in Latin America and the Caribbean



Source: Climate Watch Data (2021).

2.2 Mitigation Policies

Climate change mitigation policies aim to reduce GHG emissions. These policies can be broadly classified into two categories: those that directly affect the cost of emissions, such as carbon pricing and subsidies, and those that implement direct regulations to modify emitter behavior through measures like emissions quotas, technological requirements, or land-use restrictions. This article will focus on analyzing the distributional impacts of some of these mitigation policies related to the largest emitting sectors in LAC. These include:

- **Policies that influence the cost of emissions:**
  - **Carbon Pricing:** Carbon pricing policies include carbon taxes and emissions trading systems (cap-and-trade) and represent a direct financial mechanism to discourage emissions. For example, Chile introduced a carbon tax in 2014, primarily targeting the energy sector and covering the country's largest electricity generators (Ministerio de Energía (Chile), 2017). As of 2023, only Argentina, Chile, Colombia, Mexico, and Uruguay had an explicit carbon tax, with low average rates of US$5/tCO2e covering, on average, only 26 percent of total GHG emissions.[1] In 2020 Mexico launched a pilot emissions trading system, covering major emitters in the energy and industrial sectors (ICAP, 2023).
  - **Elimination of Fossil Fuel Subsidies:** Efforts are underway across the region to phase out fossil fuel subsidies, which encourage consumption of these energy sources. Global fossil fuel subsidies, both "explicit" (that is, undercharging of supply costs) and "implicit" (undercharging of externalities) have reached 7.1 percent of global GDP according to the IMF (Black et al., 2023). In the case of Latin America and the Caribbean, explicit and implicit subsidies amount to approximately 6.2 percent of the region's GDP (Black et al., 2023). Removing these subsidies is critical to correct market distortions and reflect the true cost of carbon emissions, fostering a more sustainable energy landscape.
  - **Subsidies for Renewable Energies:** Subsidies for renewable energies are financial incentives to promote the development and adoption of clean energy technologies, such as solar, wind, and hydroelectric. While the costs of renewable energy technology have fallen in recent decades, subsidies further reduce the costs of these technologies, making them

[1] See https://carbonpricingdashboard.worldbank.org.

more competitive compared to fossil fuels. For instance, in Argentina, the RenovAR program provides tax incentives and subsidies specifically designed to encourage the uptake of renewable energy projects. This initiative not only supports the local development of renewable energy but also aids in meeting the nation's sustainability goals by increasing its renewable energy capacity (International Energy Agency, 2023).

- **Payment for Ecosystem Services (PES):** PES provide financial compensation to landowners and communities that conserve and restore ecosystems that provide environmental services including carbon sequestration, biodiversity conservation, and water resource protection. Examples include programs such as Costa Rica's Payment for Environmental Services Program, which compensates landowners for forest conservation practices, and the Mexican National Forestry Commission's (CONAFOR) Payment for Environmental Services Program was established to support rural communities and landowners in forest conservation by providing payments for services such as watershed protection and biodiversity conservation.

- **Regulatory Policies:**
  - **Emission Quotas and Sectoral Limitations:** Regulations that establish maximum emission limits for specific sectors, such as industry and transportation promote the adoption of cleaner technologies through energy efficiency standards, the adoption of abatement technologies, and vehicle emission regulations. An example of this is Brazil's Vehicle Emissions Control Program (Programa de Controle de Emissões Veiculares - PROCONVE), which sets emission limits for vehicles, encouraging the adoption of cleaner technologies like catalytic converters and more efficient engines.
  - **Land Use Restrictions:** Land use restrictions include policies aimed at protecting forests and promoting sustainable agricultural practices, such as the creation of protected areas, and regulations that limit agricultural expansion in environmentally sensitive areas. Sensitive areas are characterized by their ecological importance or vulnerability, such as regions with rich biodiversity, habitats critical for endangered species, essential watersheds, or areas prone to erosion. In Colombia, the National Restoration Plan promotes reforestation and restoration of degraded lands by establishing protected areas, offering incentives for sustainable agricultural practices, and regulating land use to prevent deforestation (Climate Action Tracker, 2022).

- **Deforestation-Free Certifications:** Deforestation-free certifications have been introduced to ensure that agricultural products are cultivated without additional deforestation. These certifications promote sustainable agricultural practices and help farmers access markets that demand environmentally responsible products. For example, in Malaysia and Indonesia, the Roundtable on Sustainable Palm Oil (RSPO) certification aims to reduce the impact of palm oil cultivation on deforestation. This certification ensures that palm oil is produced without contributing to deforestation, thereby promoting sustainable land-use practices and helping producers access international markets that prioritize environmentally responsible sourcing.

3. Distributive Impacts on Economic Sectors and Socioeconomic Groups

This section analyzes the distributional impacts of low-carbon transition policies on different economic sectors and socioeconomic groups. We explore how specific mitigation policies, described in Section 2, affect economic sectors: primary activities like agriculture, forestry and mining; secondary activities such as manufacturing and construction; and tertiary activities, which is services. Across sectors, the analysis focuses on the economic activities that are most directly affected by specific mitigation policies targeting emissions reductions in the largest emitting sectors in LAC: AFOLU and Energy (divided between i) electricity generation and fossil fuel exploration and ii) and transportation). The analysis will focus on the impacts of mitigation policies across geographic areas and socioeconomic groups. Regarding the latter, given the focus of this paper on assessing the distributional implications of transition policies, the analysis will focus on groups that are deemed "vulnerable" according to the literature.[2]

3.1 Agriculture, Forests, and Other Land Uses (AFOLU)

Mitigation policies in this area, include subsidies for sustainable practices and direct regulations such as land use restrictions, deforestation-free certifications that ensure agricultural products do not contribute to deforestation, and Payments for Ecosystem Services (PES) that remunerate

[2] In the sphere of climate change policy, "vulnerable socioeconomic groups" typically include those segments of the population that are disproportionately affected by the impacts of climate change due to their economic, social, or demographic characteristics. These groups often have limited resources and capacities to adapt to and recover from climate-related shocks and stresses. Key vulnerable socioeconomic groups include low-income populations, elderly people, children, people with special abilities, indigenous communities, women, and migrants and refugees.

landowners for conserving and restoring ecosystems. The following analysis explores how these policies aimed at avoiding deforestation, reforestation, and afforestation, and modernizing agriculture can impact economic sectors and socioeconomic groups.

Many mitigation policies in the AFOLU sector provide benefits to the primary sector. Forest conservation, restoration, and forest expansion policies offer significant benefits to agriculture by helping regulate local climate and preserve water resources, benefiting agriculture in nearby regions (IPCC 2022). Sustainable practices, such as preserving large blocks of natural habitat, enhance biodiversity and ecosystem services, which are essential for agricultural productivity (IPCC 2022). Healthy forests also preserve watersheds, providing potable water and irrigation, which are crucial for agriculture (Baumgartner, 2019). Additionally, forest conservation contributes to carbon sequestration, mitigating climate change and stabilizing hydrological regimes, which benefits agriculture in the long term (Bateman and Balmford, 2023).

Deforestation-free certifications aim to ensure that agricultural products and commodities are produced without additional deforestation. Studies indicate that the RSPO certification, for instance, reduced deforestation by 33 percent in Indonesia (Carlson et al., 2018). This is beneficial for the agricultural sector as it guarantees the continuity of ecosystem services essential for agricultural production. PES programs also promote sustainability in the agricultural sector. In Costa Rica, the PES program encourages forest conservation and the adoption of agroforestry practices by offering payments to farmers in exchange for ecosystem services from forests. These payments help improve soil and water quality, which are essential for agricultural productivity, and enhance crop resilience against extreme weather events (Pagiola, 2008). Additionally, they provide a complementary source of income for farmers, making environmental conservation an economically viable activity (Pagiola, 2008).

Mitigation policies in the AFOLU sector may also benefit the secondary sector and the tertiary sector. Improving agricultural productivity and enhancing crop resilience stabilizes the supply of raw materials, ultimately benefiting industries reliant on consistent and high-quality agricultural inputs. Further, adopting sustainable practices, such as sourcing from suppliers with deforestation-free certifications can enhance the reputation of companies, attracting environmentally conscious consumers and investors. In the service sector, forest conservation policies can positively affect eco-tourism (Rafa et al., 2021).

However, mitigation policies in the AFOLU sector can also have negative impacts in the primary sector. Forest conservation, restoration, and forest expansion policies can restrict farmers' access to arable land, necessitating the intensification of agriculture or forest production on the remaining plots. Intensification without sustainable practices may lead to soil degradation and a decline in agricultural productivity due to the overexploitation of natural resources.[3] For example, while the intensification of forest production can increase resource efficiency and reduce emissions in certain contexts, it often occurs at the expense of biodiversity and ecosystem quality, which can, in turn, compromise long-term sustainability (Baumgartner, 2019). Lack of an integrated approach to forest management, land use, and agricultural policies can exacerbate these issues, creating conflicts between conservation goals and agricultural needs, resulting in negative consequences for both the environment and long-term economic sustainability Baumgartner, 2019).[4]

Additionally, mitigation policies in the AFOLU sector can have negative effects for the secondary and tertiary sectors. For the industrial sector, particularly agro-processing and related manufacturing industries, stricter land use and sustainable practices can lead to increased costs of inputs. Similarly, in the service sector, firms dependent on traditional agricultural outputs might face disruptions in their supply chain or higher costs due to changes in land use and agricultural practices.

Mitigation policies in the AFOLU sector have varied effects on socioeconomic groups. Many of these policies can have positive effects on vulnerable groups.

First, certifications and PES programs can increase income and provide financial stability. According to Furumo et al. (2020), certification can result in price premiums for agricultural products, thereby increasing the income of certified farmers. Although yields may be lower, the sale of products at higher prices due to price premiums compensates for this difference. These price premiums incentivize small farmers to join and remain in certification schemes, which can

[3] Reducing the expansion of agricultural land without a decrease in food demand or an increase in productivity in other parts of the country increases the need for imports, which means more damage to biodiversity and natural habitats elsewhere (Bateman and Balmford, 2023). In fact, crop imports by the EU over the 25 years up to 2014 resulted in the destruction of more than 11 million hectares of habitat, affecting some of the world's most biodiverse ecosystems, such as those in Brazil and Indonesia (Bateman and Balmford, 2023).

[4] Moreover, the implementation of conservation policies may lead to land use conflicts. Without appropriate governance and the inclusion of local communities, these policies can exacerbate issues such as corruption and inadequate monitoring, ultimately resulting in forest degradation and decreased agricultural productivity. In regions such as Southeast Asia, for instance, reforestation and forest conservation policies have not always been effective due to insufficient support and commitment from local governments, which perpetuates unsustainable land use practices (https://www.mdpi.com/2071-1050/8/7/620).

provide a source of financial stability. Certification provides greater economic security, as many certified farmers have contracts to sell their products to guaranteed buyers, reducing economic uncertainty (Furumo et al., 2020). Further, certified farmers tend to pay higher wages to workers compared to non-certified farmers, which contributes to better socioeconomic conditions in farming communities (Furumo et al., 2020). Similarly, PES programs provide financial incentives to small farmers for conserving forest areas and adopting agroforestry practices, thereby providing a guaranteed stream of income and promoting sustainable agricultural practices (Pagiola, 2008). PES programs designed to prioritize poor areas for participation and direct resources to these areas may have greater positive socioeconomic impacts.

Second, certification offers access to technical support and training programs, helping small farmers improve their agricultural practices and increase efficiency.

Third, forest conservation, restoration, and forest expansion policies can also enhance the autonomy of traditional and indigenous communities and enhance income. These policies can provide traditional and indigenous communities with formal land rights and recognize their citizenship. For instance, in Brazil, the establishment of Sustainable Use Conservation Units[5] protects these communities from encroachment by farmers and ranchers, thereby securing their land rights (Kohler and Brondizio, 2017). Well-managed forestry activities, such as timber production, non-timber forest products, and ecotourism, can create labor-intensive jobs and generate income in traditional and indigenous communities, helping to reduce local poverty (Baumgartner, 2019; Wiebe et al., 2021). These jobs are particularly advantageous for low-skilled workers (Wiebe et al., 2021). Additionally, these policies promote agricultural conservation by reducing dependence on expensive chemical inputs, increasing soil sustainability, and making agriculture more resilient to climate change, thus protecting the economic base of these communities (Wiebe et al., 2021; Kohler and Brondizio, 2017).

Mitigation policies in the AFOLU sector can also negatively impact vulnerable groups. First, agricultural modernization policies, sustainable land-use regulations, and deforestation-free certifications can lead to land concentration and economic marginalization. Vulnerable groups can be marginalized by these policies because they lack the financial and technical resources to comply with them. Agricultural modernization policies often emphasize large-scale operations that use

[5] Sustainable Use Conservation Units, known as *Unidades de Conservação de Uso Sustentável* in Brazil, are protected areas designated to allow sustainable use of natural resources by local communities while conserving biodiversity.

advanced technologies and intensive inputs, leading to land concentration and industrialization that marginalizes small farmers, and especially women, who lack financial resources to adopt these new technologies (Knickel et al., 2017). Women in particular often face discrimination in access to credit and technology. Sustainable land-use practices may involve new techniques and increased labor demand, which can be burdensome for small-scale farmers operating with limited resources. The uncertainty regarding the effectiveness of these new practices in maintaining or enhancing crop productivity discourages small-scale farmers with limited financial resources from adopting these practices (Akanmu et al., 2023). Similarly, deforestation-free certifications can exclude small-scale farmers and women, especially in contexts in which women have limited access to resources. Deforestation-free certifications require compliance with stringent social and environmental criteria, which can be costly and complex to implement (Furumo et al., 2020). The high initial costs of obtaining certification, including audit fees and investments to meet the required standards, impose a significant barrier. Maintaining certification can also be expensive due to the need for periodic audits and ongoing adherence to certified practices. This can exclude small farmers from certified markets, limiting their potential benefits and exacerbating economic marginalization (Furumo et al., 2020).

Second, mitigation policies in the AFOLU sector can disrupt cultural practices and traditional livelihoods, dispossess vulnerable groups from their customary land rights, and lead to forced displacement of indigenous communities. Forest conservation policies frequently impose restrictions on the use of natural resources that are essential for indigenous communities' subsistence and cultural practices. The implementation of these policies can overlook local rights and needs, leading to conflicts over resource use and the exclusion of these communities from decision-making processes. Indigenous and traditional communities often face forced displacement and loss of access to their ancestral lands (Kohler and Brondizio, 2017). Furthermore, deforestation-free certification often requires formal land titles, which can dispossess women of their customary, and informally recognized land rights because titles are traditionally registered in men's names in many cultures.

Third, the benefits of policies such as PES and deforestation-free certifications typically only accrue to those that have formal title to the land and control over its resources, implying that these policies could exacerbate existing inequalities. For instance, women frequently have less

access to and control over forest and tree resources, which limits their ability to benefit from forest conservation, restoration, and expansion policies (Mwangi et al., 2011).

Overall, the evidence indicates that complementary policies will be necessary to ensure that the benefits and costs of mitigation policies in the AFOLU sector are equitably distributed across all sectors and socioeconomic groups.

3.2 Energy (Electricity Generation and Fossil Fuel Exploitation)

Mitigation policies in the energy sector encompass a variety of strategies, including carbon pricing through carbon taxes and cap-and-trade systems, as well as the removal of fossil fuel subsidies. Additionally, they include direct regulations such as emission standards, bans on new licenses for fossil fuel exploration, the substitution of fossil fuel sources with renewables, and the implementation of carbon capture, utilization, and storage (CCUS) technologies.

These policies to transition to a low-carbon energy sector can generate significant positive impacts on the economy as a whole. Job creation and economic stimulus are notable, with a significant increase in the number of direct and indirect jobs in areas such as the construction and maintenance of solar and wind installations (Liao, 2023). Investment in renewable energy can boost economic growth, increase national income, improve the trade balance, develop industries, and increase employment, especially in middle- and low-income countries (Liao, 2023). Furthermore, adopting renewable energies can significantly reduce long-term operational costs in all economic sectors, as these energy sources have lower operation and maintenance costs compared to fossil fuels.

The following analysis explores the impacts of these policies on different economic sectors and socioeconomic groups, highlighting how the transition to renewable energy sources and stricter regulation of fossil fuel exploration can reshape the economic and social landscapes.

In the primary sector, policies to transition to low-carbon energy can increase agricultural producers' income through specific channels. Renewable energy can reduce operational costs for farms through the installation of solar panels and wind turbines, which provide electricity for various agricultural activities, decreasing the reliance on fossil fuels (IRENA, 2021). Additionally, farmers can generate extra income by leasing their land for these installations. Furthermore, techniques such as integrated soil management that increase the capacity of agricultural lands to absorb carbon enhances soil quality and long-term productivity and can increase farmers' income

by selling carbon credits in emission trading programs. Biogas production from agricultural waste reduces operational costs and generates additional income through the sale of surplus energy and carbon credits in emission trading programs (IRENA, 2021). Moreover, low-carbon energy practices can improve farmers' standing with consumers, allowing access to markets that value sustainable products and resulting in premium prices for their goods.

Policies to transition to a low-carbon energy sector can also deliver positive impacts in the secondary and tertiary sectors. Carbon pricing policies can incentivize innovation and energy efficiency. Particularly in the secondary sector, implementing carbon prices motivates industries to invest in cleaner, more efficient technologies, leading to long-term cost reductions. Adopting new technologies and improving production processes allow industries to adjust and eventually gain competitiveness (World Bank, 2023). Additionally, these policies can create new markets and opportunities for low-carbon products and services in the secondary and tertiary sectors. Companies can explore market niches by developing sustainable products that meet the growing demand for environmental solutions, including sectors such as renewable energy and carbon capture and storage technologies.

Low-carbon transition policies in the energy sector can also have negative impacts on the primary, secondary, and tertiary economic sectors.

Carbon pricing policies, such as carbon taxes, affect the primary sector by increasing production costs. These policies lead to higher agricultural production costs due to the immediate need for farmers to adopt technologies that reduce emissions (Zhang et al., 2024). This can result in reduced profit margins and make agricultural products less competitive both domestically and internationally. In particular, small farmers may be disproportionately affected due to their lower financial capacity to invest in emission-reducing technologies or adapt their agricultural practices (Zhang et al., 2024).

The secondary sector can also be negatively affected by mitigation policies in the energy sector. The transition to renewable energies can introduce uncertainty and risks, such as the intermittency of solar and wind energy sources, affecting the reliability of supply for industrial processes. In addition, carbon pricing policies increase operational costs for carbon-intensive industries. Sectors like oil refineries, chemical manufacturing, primary metals, and non-metallic minerals face significant cost increases, potentially exceeding 4 percent of total production costs, negatively affecting profitability and competitiveness in the short term (Ho et al., 2008).

Additionally, exposure to international trade makes some industries vulnerable to market losses due to carbon policies. Sectors with high emission intensity and significant trade exposure, such as aluminum and steel, face additional challenges competing with producers in countries without similar policies, resulting in declines in exports and negative impacts on the industrial sector's value-added (World Bank, 2023).

Countries in the region can also be impacted by policies to transition to low-carbon energy sources implemented outside their borders. For example, a significant concern with carbon pricing policies is the risk of carbon leakage. Carbon leakage occurs when sectors relocate their operations to countries with less stringent environmental regulations to avoid the higher costs associated with carbon pricing in their home country. This relocation undermines the environmental benefits of carbon policies and can lead to job losses and reduced competitiveness in countries with stricter environmental policies.

To address this challenge, many countries are implementing border carbon adjustments (BCAs), which equalize the carbon price on imported goods to that of domestically produced goods, preventing carbon leakage and leveling the playing field (World Bank, 2023). By ensuring that imports face the same carbon price as domestic products, BCAs mitigate the competitive disadvantage faced by industries in countries with stringent carbon policies. This policy can also encourage other countries to adopt similar carbon pricing mechanisms to avoid trade barriers, promoting a more global approach to carbon emissions reduction. However, the implementation of BCAs can also lead to trade tensions and affect international relations, since regions heavily reliant on exports to countries with BCAs may face higher costs and reduced market access.

Although many LAC countries, for example, have not adopted BCAs, they will still face significant impacts from these policies. Countries in Latin America, especially the secondary sector, may face competitive disadvantages in international markets if they do not transition to low carbon energy while other countries do, as their exported products pay the carbon adjustment, making them more expensive and less competitive. However, BCAs may represent a significant opportunity for the secondary sector in LAC. The region has comparative advantages in clean energy and natural resources, which can open new export opportunities in sectors such as renewable energy and sustainable manufacturing.

Mitigation policies in the energy sector have heterogenous impacts on socioeconomic groups. There are numerous potential positive impacts for vulnerable households. First, this

transition has the potential to make energy more accessible and reliable for low-income families in the long term, reducing their dependence on expensive and polluting energy sources. This can lower direct energy costs and improve living standards, health, and housing conditions for these populations.

Second, policies to transition to a low-carbon energy sector can have positive impacts on employment, investment, and the environment in local and indigenous communities. The presence of clean energy projects can attract investments, improve local infrastructure, and create jobs, in addition to offering training programs that increase employment levels and skills within the community (Wanderley and Leão, 2023). While the initial installation of renewable energy infrastructure may have negative environmental impacts, in the long term, the energy transition contributes to reducing dependence on fossil fuels, decreasing deforestation, and protecting areas of native forest, thereby promoting biodiversity conservation and climate change mitigation. This strengthens the local economy and promotes greater resilience to climate change, encouraging the development of new technologies and more efficient practices (Wanderley and Leão, 2023). Energy transition policies, especially those related to strict environmental regulation, can improve air and water quality in indigenous territories and preserve the natural environment and biodiversity, which are crucial for their livelihood and culture. Additionally, conservation policies can strengthen indigenous populations' territorial rights, ensuring that their lands are preserved from destructive activities such as mining and fossil fuel exploration (Birkmann et al., 2022).

Third, the transition to a low-carbon energy sector provides an opportunity to improve the inclusion of women in the energy sector. Many jobs in the energy sector are well-paid formal jobs, but women are under-represented in this sector. However, if transition policies are not inclusive, women may face negative challenges, being excluded from the benefits of the transition to renewable energies due to lack of access to adequate training and reskilling opportunities, perpetuating existing gender inequalities in the labor market (Groves et al., 2022).

Low-carbon transition policies in the energy sector can also negatively impact vulnerable groups, exacerbating existing inequalities. First, these policies can lead to higher food and energy prices. During the transition period, investments in renewable energy infrastructure and the elimination of fossil fuel subsidies may result in temporary increases in energy costs and the burden of carbon pricing can be partially passed on to consumers, increasing living costs, especially prices for emissions-intensive goods like meat, dairy, and energy (Shang, 2023). Low-

income families that spend a larger proportion of their income on food and energy are particularly vulnerable to these price increases (Vogt-Schilb et al., 2019).[6] Without compensatory policies, these price increases could exacerbate poverty and compromise the economic and human development of these communities (González-Eguino, 2015).

Second, policies to transition to a low-carbon energy sector can negatively impact employment in fossil fuel industries, including coal, oil, and gas. The reduced demand for fossil fuels can result in a decrease in job opportunities, leading to significant unemployment in regions that are economically dependent on these activities (Shang, 2023). The deindustrialization of these areas can lead to a protracted reduction in employment opportunities in supporting sectors and local economic activity.

Specifically, in the coal mining industry, economic activities and employment are geographically concentrated. Policies to transition to low-carbon energy will result in the closure of mines and plants, eliminating jobs and reducing local tax revenue, thus destabilizing the economy of coal mining communities (Wanderley and Leão, 2023). In Chile, for instance, the coal-fired power generation sector employs approximately 4,400 direct jobs and 9,500 indirect jobs, representing 0.17 percent of the total employment in the country (Viteri Andrade, 2019). Therefore, energy transition policies need to consider mitigation strategies for these negative impacts, ensuring that affected communities have access to alternative employment opportunities and adequate economic support during the transition.

Third, traditional and indigenous communities, especially those near renewable energy projects, may be negatively affected by energy transition policies. These communities frequently face exclusion from decision-making and planning processes, resulting in an unequal distribution of project benefits, reinforcing existing social and economic inequalities in the region (Levenda et al., 2021). Negative impacts include loss of land, restricted access to natural resources, and environmental degradation due to the installation and operation of energy infrastructure. The transition to a clean energy system also increases demand for minerals, generating social and environmental conflicts due to the expansion of mining activities in sensitive areas (Levenda et

[6] Families experienced the largest losses in terms of protein (2.05 percent) and energy consumption (1.42 percent), along with an increase in income inequality, as indicated by a 0.57 percent rise in the Gini coefficient by 2050 (Zhang et al., 2024).

al., 2021), such as the Amazon, directly affecting local communities that depend on these natural resources for their livelihood.

In summary, policies to transition to low-carbon energy have complex and varied impacts on economic sectors and socioeconomic groups. While they present significant challenges, especially for the most vulnerable groups, they also offer opportunities to promote environmental sustainability and socioeconomic development when they are implemented with complementary policies that ensure a just and inclusive transition.

3.3 Transport

The transition to a low-carbon transportation system has impacts in the primary, secondary, and tertiary economic sectors, with both positive and negative impacts. One of the primary benefits of low-carbon transportation policies is the reduction in operational costs, which benefits all economic sectors. The adoption of more efficient transportation technologies, such as electric vehicles or biofuel-powered vehicles, tends to lower maintenance and operation costs compared to traditional fossil fuel-powered vehicles. This provides significant savings for farmers, industries, and service companies, especially in regions where fossil fuels are expensive. In the agricultural sector, for instance, this cost reduction can be particularly beneficial for farmers who rely on long-distance transportation to distribute their products.

In all economic sectors, the transition to sustainable transportation technologies can improve companies' environmental reputation, a factor increasingly valued by consumers and investors. Companies adopting sustainable practices in compliance with mitigation policies can attract new customers and investors, creating new business opportunities and increasing customer loyalty. Producers across all sectors can benefit from improved environmental reputations, from farmers who can access markets that value sustainable products to industries and service companies that can stand out for their eco-friendly practices.

In the primary economic sector, policies promoting the use of biofuels can create additional markets for agricultural products, providing an extra source of income for farmers who grow energy crops, such as corn and sugarcane.

The secondary economic sector could experience positive impacts of policies to transition to sustainable transportation technologies because these policies promote the creation of new markets and business opportunities. In the industrial sector, this manifests in the production of

electric vehicles, charging infrastructure, and the development of green technologies. The automotive industry, for example, can benefit as the growing demand for electric vehicles opens new markets and opportunities for innovation. Manufacturers that adapt quickly can lead in green technology and gain a competitive advantage (UNFCC, 2018).

Policies promoting low-carbon transportation can also have positive impacts in the tertiary sector. These policies can stimulate innovation within the service sector, leading to the development of new products and services. This can open new markets and growth opportunities while positioning companies as sustainability leaders. For example, the promotion of shared mobility and the shift from private vehicles to public transportation modes, such as trains, subways, and buses, stimulate innovation in mobility services. Companies can develop apps and digital platforms that facilitate the use of these transportation modes, offering integrated solutions that improve connectivity and the efficiency of public transport systems (Boston Consulting Group, 2024). Additionally, implementing fleet management systems to improve cargo transport efficiency can lead to new services for route monitoring and optimization, creating new business opportunities in the service sector.

However, these policies may also have negative impacts for each of the economic sectors. Transitioning to low-carbon technologies in the transportation sector requires considerable investment in infrastructure and new equipment, posing a financial challenge for producers in all sectors, especially those with narrower profit margins (Din et al., 2023). Moreover, policies that increase transportation costs, such as carbon taxes and congestion charges, can raise agricultural and industrial production costs, reducing profit margins.

Another potential negative impact that affects all economic sectors is the disruption of supply chains. Changes in transportation infrastructure and stricter regulations can cause delays in delivering raw materials and finished products, negatively impacting the operational efficiency of industries and service companies (SLOCAT, 2021). These disruptions can be particularly challenging in a global market, where companies in countries with stricter environmental policies may face competitive disadvantages compared to companies in countries with less stringent regulations, resulting in loss of international market share.

Low-carbon transition policies in the transportation sector can also have negative impacts that occur specifically in the primary sector. The conversion of agricultural land for biofuel production often displaces essential food crops, which not only exacerbates the pressure on limited

agricultural resources but can also lead to an increase in food prices due to reduced supply. This displacement may force farmers to compete for fertile land, which may drive up production costs for the production of food crops and stimulate deforestation, and lead to the unsustainable intensification of agricultural activity.

In addition to impacts on economic sectors, mitigation policies in the transportation sector also have significant effects on different socioeconomic groups. Many of these policies can deliver benefits to vulnerable groups. First, expansions to public transportation and micromobility programs can connect vulnerable households to essential services and labor markets, enabling low-income households, both rural and urban, to access healthcare, education, and employment located far from their communities (McQueen et al., 2021). Informal workers can especially benefit from these policies. The expansion of public transportation services in areas with high informality rates can significantly improve formal employment opportunities for residents of these areas, helping reduce their dependence on the informal sector. Boisjoly et al. (2017) show that a 1 percent increase in public transportation accessibility reduces the probability of a worker being in the informal sector by 3 percent. Therefore, improvements in public transportation infrastructure promotes social and economic inclusion, offering informal workers better formal employment opportunities and helping reduce socioeconomic inequalities (Boisjoly et al., 2017).

Second, low-carbon transition policies for transportation can improve public health for vulnerable groups. Restructuring freight transport can benefit the urban population by reducing congestion and air pollution in urban areas (Cui, Dodson, and Hall, 2015). Diesel trucks and freight ships are major emitters of air pollution in cities. The air and noise pollution generated by freight traffic disproportionately affects low-income and minority communities. For instance, in the United States freight infrastructure, such as ports, are often surrounded by low-income and minority communities, exposing residents to higher health risks (Grobar, 2008; Houston, Krudysz, and Winer, 2008). Low-carbon fright transport can reduce emissions of air pollutants and noise, leading to significant local improvements in air quality and public health, as well as providing a more pleasant and habitable urban environment.

Low-carbon transition policies in the transportation sector can also have negative impacts on vulnerable groups and exacerbate existing inequalities. First, these policies, such as the promotion of biofuels, can increase food prices. Encouraging the cultivation of energy crops like corn and sugarcane for biofuel production creates direct competition for agricultural land that

could be used for food production. This can lead to higher food prices as the supply of land for food cultivation decreases. Because lower-income households spend a greater fraction of their budgets on food and live on very tight budgets, these households are disproportionately affected by higher food prices.

Second, lower-income residents may be excluded from the benefits of low-carbon transportation policies, such as public transport networks. Improvements in public transport infrastructure are often concentrated in high-income urban areas. This perpetuates socioeconomic inequalities by restricting informal and low-income workers' access to more lucrative urban markets and better employment opportunities. Boisjoly et al. (2017) found a direct relationship between low public transport accessibility and a higher likelihood of being employed in the informal sector, especially among those earning less than the minimum wage. Furthermore, when public transport infrastructure is improved in lower-income communities, it can lead to gentrification, increasing the cost of living and potentially displacing lower-income residents who cannot afford the rising housing and living costs. Despite improvements in transportation infrastructure, financial and access barriers may persist, preventing low-income communities from fully benefiting from these services.

Low-carbon transition policies in the transportation sector can also negatively impact indigenous and traditional communities' access to land and cultural, social, and economic sustainability. The transition of freight transport from trucks to railways and ships can reduce greenhouse gas emissions in the transportation sector. The construction of railways and the expansion of shipping routes, however, can restrict indigenous and traditional communities' access to their lands and resources, alter local ecosystems and affect their traditional activities (Ng et al., 2018). This results in changes to living patterns, directly impacting the cultural, social, and economic sustainability of these communities.

These impacts showcase the complexity of impacts of mitigation policies in the transportation sector, which are likely to bring both positive and negative impacts. To ensure a fair and inclusive transition, it is essential to complement low-carbon transition policies in this sector with policies that specifically address the needs and capacities of all affected socioeconomic groups.

4. Compensatory Strategies and Complementary Policies

Mitigation policies implemented with the purpose of reducing GHG emissions can significantly impact economic sectors and socioeconomic groups as discussed in the preceding sections. Explicitly designing transition policies for inclusiveness and simultaneously implementing complementary and compensatory policies can allow the positive impacts described above to materialize while preventing or minimizing many of the negative impacts. As the region implements low-carbon transition policies, it is crucial to integrate social and economic justice into these policies to ensure an equitable distribution of the costs and benefits of the transition to a low-carbon economy.

Ensuring that mitigation policies do not exacerbate existing inequalities in the region is an important goal from a development perspective, but it is also of practical importance to implementing climate policy. Perceptions of distributional fairness are one of the primary factors that determine citizen support for climate policies (Bergquist et al., 2022; Dechezlepretre et al., 2023), and perceptions that a climate policy is regressive can instigate backlash from citizens that extends beyond an individual policy (Douenne and Fabre, 2022).

To address the unequal distribution of costs and benefits, policies can include mechanisms to compensate citizens who will face higher consumer costs and worse economic opportunities. Governments can compensate consumers for higher prices for food, energy, and public transport as a consequence of climate policy by enhancing current cash transfer programs, implementing new cash and in-kind transfers, and providing subsidies for key consumption items. For example, carbon pricing policies may raise energy costs in the short- to medium-term, disproportionately affecting low-income households unless compensatory measures are implemented (Rentschler and Bazilian, 2017). Compensatory measures could include recycling revenues from carbon pricing to citizens through existing social protection programs or implementing new transfers. Revenue recycling programs (such as, Equal Revenue Recycling (ERR) and Progressive Revenue Recycling (PRR)) direct the funds collected back to families, with PRR particularly aimed at low-income households, thereby increasing their disposable income and improving their well-being (Zhang et al., 2024). Similarly, policies that encourage biofuels can impact food security by reducing the availability of land for food cultivation (OECD, 2019). Higher prices for public transportation and food could be offset by free or subsidized public transportation, in-kind food transfers, and cash transfers for low-income households. Governments can also compensate households for any higher

initial costs of consumer durables by offering subsidies to compensate for the higher initial prices of electric vehicles and electric cookstoves, (Missbach, Steckel, and Vogt-Schilb 2024; Schaffitzel et al. 2019). Targeting the compensatory policies well helps to keep the fiscal costs manageable. As discussed in the prior section, transition policies will have varied impacts across economic sectors. For example, while renewable energy investments can create significant job opportunities in new sectors, traditional industries such as fossil fuels and manufacturing may experience job losses (Alfonso, Herrera, and Mondragón 2022; Saget, Vogt-Schilb, and Luu, 2020). The net change in jobs associated with the transition to a low-carbon economy is positive for the region (Saget, Vogt-Schilb, and Luu 2020), but the creation of green jobs may not immediately offset the losses in brown jobs and the geographic distribution of jobs and the skills required may shift. Governments can implement policies to compensate workers who will face worse economic opportunities in a low-carbon economy and assist them in re-integrating into the economy. Further, governments can implement policies aimed at increasing women and indigenous people's access to new jobs created in the transition. For instance, the inclusion of women in new job opportunities in the renewable energy sector through targeted training and education initiatives can promote gender equality in the workforce. Governments can support workers in transitioning to different industries (Shang, 2023), for example, through reskilling and upskilling programs labor intermediation services, support for migration to locations with greater economic opportunity, and temporary employment programs that, for example, can provide immediate job opportunities in post-disaster scenarios. Unemployment insurance can provide crucial support to workers who fall through these cracks. Having strategies to support workers and communities affected by transition policies is essential for making these policies acceptable and fair. Ensuring job quality, market access, and strong social protection are key elements of the transition (Alfonso et al., 2023).

Governments can also take this opportunity to broadly strengthen social protection measures to support workers during concurrent labor market disruptions from automation, artificial intelligence, or other sources. These measures help maintain income levels and provide stability as workers adapt to new employment opportunities in the green economy.

In addition to compensating citizens for changes in income and consumer prices, governments can implement complementary policies that promote equal access to the benefits of transition policies. Governments can design new low-carbon infrastructure with inclusiveness as an explicit goal. For instance, transportation infrastructure to provide public transportation and

micromobility can be designed to avoid disproportionately benefiting those who already have greater access to resources and services. Dense public transit networks with good coverage outside the urban core will allow lower-income and informal workers to share in the benefits. Rent stabilization or rent vouchers can be used to ensure that current residents are not displaced by raising housing costs along transit corridors. Long-term, low-interest mortgages can allow lower-income residents to share some of the benefits of rising housing costs. Similarly, clean energy infrastructure can be designed to reduce existing inequalities by providing universal access to modern energy sources and avoiding the worst effects of energy poverty. Investments in clean energy infrastructure often do not reach the poorest communities or are implemented in ways that do not consider the needs and capacities of these populations. Designing infrastructure to improve energy access while transitioning to low-carbon energy reduce inequalities (González-Eguino, 2015). Governments can also implement policies to ensure widespread and fair land titling to allow access to programs such as deforestation free certifications and payments for ecosystem services. For instance, legal restrictions initially prevented many poor farmers from participating in Costa Rica's PES program due to their lack of formal land titles. To address this issue, the Costa Rican government created parallel contracts funded by private sources, allowing these farmers to participate in the program. Later, the legislation was amended to formally include these landowners, increasing social and economic inclusion and ensuring that more people could benefit from the program's financial incentives (Pagiola, 2008). In particular, policies can focus on ensuring that women and indigenous people hold land titles and that customary land rights are recognized. Furthermore, governments can facilitate access to credit, utilize targeted subsidies for critical technologies, offer training, and support cooperatives for small-scale farmers to assist small-scale farmers in meeting certification requirements and modernizing their agricultural techniques.

Finally, governments can implement protections for indigenous communities. In addition to recognizing their rights to land, transition policies can aim to improve local environmental quality and protect indigenous culture and traditions.

Implementing well-designed policies that incorporate social and economic justice is imperative to mitigate adverse impacts on vulnerable groups while achieving climate goals (Dechezleprêtre et al., 2022). Transparent and inclusive policymaking processes can prevent transition policies from being captured by specific interests. Ensuring that all stakeholders,

particularly vulnerable populations, are included in the policy design process helps address specific needs and promotes a fair distribution of benefits. Women are often excluded from decision-making processes at the household, community, and national levels, which makes them particularly vulnerable when policies, such as land use policies (Mwangi et al., 2011), are implemented. Governments can also seize this opportunity to rethink inequality and social protection more broadly. By integrating these strategies, LAC can achieve its climate goals while promoting equity and reducing the socioeconomic disparities exacerbated by climate change and transition policies. The focus on social and economic justice enhances the effectiveness of climate mitigation policies and ensures that the transition to a low-carbon economy is inclusive and sustainable.

References

Akanmu, A. O., Akol, A. M., Ndolo, D. O., Kutu, F. R., and Babalola, O. O. (2023). Agroecological techniques: Adoption of safe and sustainable agricultural practices among the smallholder farmers in Africa. *Frontiers in Sustainable Food Systems*, *7*, 1143061.

Bateman, I., and Balmford, A. (2023). Current conservation policies risk accelerating biodiversity loss. Nature, 618, 671-674.

Baumgartner, R. J. (2019). Sustainable development goals and the forest sector—A complex relationship. Forests, 10(2), 152.

Bergquist, Magnus, Andreas Nilsson, Niklas Harring, and Sverker C. Jagers. 2022. "Meta-Analyses of Fifteen Determinants of Public Opinion about Climate Change Taxes and Laws." Nature Climate Change 12 (3): 235–40. https://doi.org/10.1038/s41558-022-01297-6.

Birkmann, J., E. Liwenga, R. Pandey, E. Boyd, R. Djalante, F. Gemenne, W. Leal Filho, P.F. Pinho, L. Stringer, and D.Wrathall, 2022: Poverty, Livelihoods and Sustainable Development. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 1171–1274, doi:10.1017/9781009325844.010.

Black, Simon, Antung Liu, Ian Parry, and Nate Vernon, 2023. "IMF Fossil Fuel Subsidies Data: 2023 Update." Working paper, IMF, Washington, DC. https://www.imf.org/en/Publications/WP/Issues/2023/08/22/IMF-Fossil-Fuel-Subsidies-Data-2023-Update-537281

Boisjoly, G., Moreno-Monroy, A. I., and El-Geneidy, A. (2017). Informality and accessibility to jobs by public transit: Evidence from the São Paulo Metropolitan Region. *Journal of Transport Geography, 64*, 89-96. https://doi.org/10.1016/j.jtrangeo.2017.08.005

Boston Consulting Group. (2024). Accelerating the Shift to Sustainable Transport. Retrieved from https://www.bcg.com/publications/2024/accelerating-the-shift-to-sustainable-transport

Brannlund, Runar, and Lars Persson. 2012. “To Tax, or Not to Tax: Preferences for Climate Policy Attributes.” Climate Policy 12 (6): 704–21. https://doi.org/10.1080/14693062.2012.675732.

Carlson, K. M., Heilmayr, R., Gibbs, H. K., Noojipady, P., Burns, D. N., Morton, D. C., ... and Kremen, C. (2018). Effect of oil palm sustainability certification on deforestation and fire in Indonesia. *Proceedings of the National Academy of Sciences*, *115*(1), 121-126.

Climate Action Tracker. (2022). *Country assessments*. Climate Action Tracker. Retrieved from https://climateactiontracker.org/

Climate Watch. (2021). *GHG emissions by sector in Latin America and Caribbean*. World Resources Institute. Retrieved June 7, 2024, from https://www.climatewatchdata.org/ghg-emissions

Costa, S., Casanova, C., and Lee, P. (2017). What does conservation mean for women? The case of the Cantanhez Forest National Park. Conservation and Society, 15(2), 168-178.

Cui, J., Dodson, J., and Hall, P. V. (2015). Planning for urban freight transport: An overview. *Transport Reviews, 35*(5), 583-598. https://doi.org/10.1080/01441647.2015.1038666

Dechezleprêtre, Antoine, Adrien Fabre, Tobias Kruse, Bluebery Planterose, Ana Sanchez Chico, and Stefanie Stantcheva. 2022. “Fighting Climate Change: International Attitudes Toward Climate Policies.” w30265. Cambridge, MA: National Bureau of Economic Research. https://doi.org/10.3386/w30265.

Din, A. U., Ur Rahman, I., Vega-Muñoz, A., Elahi, E., Salazar-Sepúlveda, G., Contreras-Barraza, N., and Alhrahsheh, R. R. (2023). How sustainable transportation can utilize climate change technologies to mitigate climate change. *Sustainability, 15*(9710). https://doi.org/10.3390/su15129710

Furumo, Paul R., Ximena Rueda, Juan Sebastián Rodríguez, and Isabel Katsí Parés Ramos. "Field evidence for positive certification outcomes on oil palm smallholder management practices in Colombia." *Journal of Cleaner Production* 245 (2020): 118891. González-Eguino, M. (2015). Energy poverty: An overview. Renewable and sustainable energy reviews, 47, 377-385.

Grobar, L. M. (2008). The economic status of areas surrounding major U.S. container ports: Evidence and policy issues. *Growth and Change, 39*(3), 497-516.

Groves, D. G., Molina-Perez, E., Syme, J., Alvarado, G., De León Denegri, F., Acuña Román, J. D., and Jenkins Rojas, A. (2022). *A Green Costa Rican COVID-19 Recovery: Aligning Costa Rica's Decarbonization Investments with Economic Recovery*. RAND Corporation. https://www.rand.org/pubs/research_reports/RRxxxx.html

GLOBAL COMPLIANCE NEWS. Brazil: Federal Decree sets up national system for reduction of emissions of effect gases and sectoral plans for climate change mitigation. Global Compliance News, July 28, 2022. Available at: https://www.globalcompliancenews.com/2022/07/28/brazil-federal-decree-sets-up-national-system-for-reduction-of-emissions-of-effect-gases-and-sectoral-plans-for-climate-change-mitigation150722/. Accessed on: 13th May of 2024.

Guzmán, L. A., Arellana, J., Oviedo, D., Herrera, D. C., and Sarmiento, O. L. (2023). Lifting urban mobility for the poor: Cable-cars, travel satisfaction and subjective well-being. Transportation Research Part D: Transport and Environment, 119, 103765.

Ho, M. S., Morgenstern, R. D., and Shih, J. S. (2008). Impact of carbon price policies on US industry.

Houston, D., Krudysz, M., and Winer, A. M. (2008). Diesel truck traffic in low-income and minority communities adjacent to ports: Environmental justice implications of near-roadway land use conflicts. *Transportation Research Record: Journal of the Transportation Research Board, 2067*(1), 38-46.

International Monetary Fund. (n.d.). *Energy subsidies*. Retrieved [03.06.2024], from https://www.imf.org/en/Topics/climate-change/energy-subsidies

International Energy Agency. (2023). *Latin America energy outlook*.

IRENA, F. (2021). Renewable energy for agri-food systems: Towards the Sustainable Development Goals and the Paris Agreement.

Knickel, K., Ashkenazy, A., Chebach, T. C., and Parrot, N. (2017). Agricultural modernization and sustainable agriculture: Contradictions and complementarities. International journal of agricultural sustainability, 15(5), 575-592.

Kohler, F., and Brondizio, E. S. (2017). Considering the needs of indigenous and local populations in conservation programs. Conservation Biology, 31(2), 245-251.

Levenda, A. M., Behrsin, I., and Disano, F. (2021). Renewable energy for whom? A global systematic review of the environmental justice implications of renewable energy technologies. Energy Research & Social Science, 71, 101837.

Liao, Z. (2023). Assessing Sustainable Impacts of Green Energy Projects for the Development of Renewable Energy Technologies: A Triple Bottom Line Approach. *Processes*, *11*(8), 2228.

McQueen, M., Abou-Zeid, G., MacArthur, J., and Clifton, K. (2021). Transportation transformation: Is micromobility making a macro impact on sustainability? *Journal of Planning Literature, 36*(1), 46-61. https://doi.org/10.1177/0885412220972696

Mexican Emissions Trading System. International Carbon Action Partnership, 2023.

Milani, L., Mohr, D., and Sandri, N. (2021). *Built to last: Making sustainability a priority in transport infrastructure*. McKinsey & Company. Retrieved from https://www.mckinsey.com/

Mwangi, E., Meinzen-Dick, R., and Sun, Y. (2011). Gender and sustainable forest management in East Africa and Latin America. Ecology and society, 16(1).

Nabuurs, G-J., R. Mrabet, A. Abu Hatab, M. Bustamante, H. Clark, P. Havlík, J. House, C. Mbow, K.N. Ninan, A. Popp, S. Roe, B. Sohngen, S. Towprayoon, 2022: Agriculture, Forestry and Other Land Uses (AFOLU). In IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.009.

Ng, A. K. Y., Andrews, J., Babb, D., Lin, Y., and Becker, A. (2018). Implications of climate change for shipping: Opening the Arctic seas. *WIREs Climate Change*, *9*(2), e507. https://doi.org/10.1002/wcc.507

OECD (2019), *Enhancing Climate Change Mitigation through Agriculture*, OECD Publishing, Paris, https://doi.org/10.1787/e9a79226-en.

Oosterveer, P., Adjei, B. E., Vellema, S., and Slingerland, M. (2014). Global sustainability standards and food security: Exploring unintended effects of voluntary certification in palm oil. *Global Food Security*, *3*(3-4), 220-226.

Pagiola, S. (2008). Payments for environmental services in Costa Rica. *Ecological economics*, *65*(4), 712-724.

Plan de Mitigación de Gases de Efecto Invernadero para el Sector Energía Ministerio de Energía, Diciembre 2017. Ministerio de Energía, División de Desarrollo Sustentable: Evelyn Stevens, Nicola Borregaard, Patricio Bofill, Juan Pedro Searle, Fiona Bello y Pauline Kennedy, Banco Mundial. Consorcio Carbon Counts (Reino Unido) y E2BIZ (Chile).

Rafa, N., Nuzhat, S., Uddin, S. M. N., Gupta, M., and Rakshit, R. (2021). Ecotourism as a forest conservation tool: An NDVI analysis of the Sitakunda Botanical Garden and Ecopark in Chattogram, Bangladesh. Sustainability, 13(21), 12190.

Rudel, T. (2023). Reforesting the Earth: The Human Drivers of Forest Conservation, Restoration, and Expansion. Columbia University Press.

Shang, B. (2023). The Poverty and Distributional Impacts of Carbon Pricing: Channels and Policy Implications. Review of Environmental Economics and Policy, 17(1), 64-85.

SLOCAT. (2021). *Tracking Trends in a Time of Change: The Need for Radical Action Towards Sustainable Transport Decarbonisation, Transport and Climate Change Global Status Report – 2nd edition*. Retrieved from https://tcc-gsr.com

UNFCC (2018). Global Car Industry Must Shift to Low Carbon to Survive – CDP. https://unfccc.int/news/global-car-industry-must-shift-to-low-carbon-to-survive-cdp

Viteri Andrade, A., 2019. Impacto económico y laboral del retiro y/o reconversión de unidades a carbón en Chile (Estudio desarrollado para el Ministerio de Energía de Chile).

Vogt-Schilb, A., Walsh, B., Feng, K. et al. Cash transfers for pro-poor carbon taxes in Latin America and the Caribbean. Nat Sustain 2, 941–948 (2019). https://doi.org/10.1038/s41893-019-0385-0

Wanderley, L. J., and Leão, P. C. R. (2023). Energy transition and the demand for aluminum in the Brazilian Amazon. Comissão Pró-Índio de São Paulo. Available at https://cpisp.org.br/

Wiebe, K. S., Andersen, T., Simas, M., and Harsdorff, M. (2021). Measuring the socioeconomic impacts of climate policies to guide NDC enhancement and a just transition: Zimbabwe green jobs assessment report (UNDP).

World Bank. (2023). *State and trends of carbon pricing 2023*. Washington, DC: World Bank. Retrieved from https://openknowledge.worldbank.org/entities/publication/58f2a409-9bb7-4ee6-899d-be47835c838f

Zhang, Q., Li, B., Liu, J. Y., Deng, Y., Zhang, R., Wu, W., and Geng, Y. (2024). Assessing the distributional impacts of ambitious carbon pricing in China's agricultural sector. *Ecological Economics*, *217*, 108082.