

TAXING AND SUBSIDIZING ENERGY IN LATIN AMERICA AND THE CARIBBEAN: INSIGHTS FROM A TOTAL CARBON PRICE APPROACH



WORLD BANK GROUP

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Executive Summary

Energy and fiscal policy are strongly linked in modern economies. Energy taxes and subsidies are relevant for fiscal sustainability both because of their share of revenue and because of the expenditure pressures subsidies create on public budgets. Energy is undoubtedly one of the key drivers of macroeconomic performance over the short, medium, and long terms. Moreover, by altering the relative prices of energy, taxes and subsidies influence the way it is produced and consumed.

A changing landscape in energy, public finance, and climate calls for a revision of the way countries in the Latin America and Caribbean (LAC) region currently tax and subsidize energy. Deep technological changes are occurring in the energy sector, particularly with the advances of competitive renewable electricity generation technologies and the associated developments in the electrification of industry and transport. The countries in the region should aspire to use the transformation of energy systems as a positive catalyst for growth. At the same time, they need to strengthen their fiscal positions and collect resources to close the gap in areas such as education and infrastructure. Improvements in social protection systems mean that the arguments that have traditionally justified subsidies on fossil fuels because of their pro-poor and pro-equity benefits are now mostly discredited. The geopolitics of fossil fuels are now, after the invasion of Ukraine by the Russian Federation and other ongoing tensions, much more uncertain. Finally, but critically, the transformation of energy systems is necessary to achieve the climate commitments of the LAC countries under the Paris Agreement.

A total carbon price (TCP) framework provides a useful perspective for the revision of energy taxes and subsidies. The TCP framework is based on three key premises. *First, energy prices matter.* Many policies are required to transform energy systems, but failing to consider how energy prices affect incentives to use, supply, and invest will increase the costs and potentially derail any transition. *Second, aligning the prices of fuels with their CO₂ content and its social costs is a desirable policy objective.* The fundamental argument in this report is that taxing fuels according to their emissions is not only good for the climate, but makes sense from a fiscal and energy technology perspective. *Third, what matters is the comprehensive effects of all taxes and subsidies on energy prices.* TCPs capture the joint impact of all fiscal instruments on the price of each fuel relative to its emissions. This includes direct carbon pricing instruments (carbon taxes or emission trading systems [ETSS]), but also indirect instruments that affect fuel prices even if the instruments are not linked to emissions, for example, excise taxes, exemptions, specific value added tax (VAT) regimes, price controls, direct subsidies, and so on. TCPs may also be broken down by sector (because sector-specific taxes and subsidies on energy are common) or aggregated to obtain a national average price of carbon emissions (an economy-wide TCP). Expressing taxes and subsidies relative to emissions provides a benchmark that is aligned with ongoing transformations in energy systems, particularly the emergence of low-carbon technology options at competitive costs, as well as climate goals.

This report estimates fuel-specific TCPs for 11 LAC countries—Argentina, Brazil, Chile, Colombia, Dominica, Jamaica, Mexico, Paraguay, Peru, St. Lucia, and Uruguay—from 2017 to 2023, and a preliminary estimate for 2024 is also constructed. TCPs in this report are built using a detailed bottom-up approach for each country and fuel type, whereby local tax information, public expenditure data, energy prices, and so on are combined under a common methodology, following Agnolucci et al. (2023, 2024) and Campmas et al. (2024). Because of this bottom-up data gathering, estimates of the TCP in this report are comprehensive, including, for instance, tax and subsidies at the local level (where relevant), as well as instruments that are usually difficult to capture, such as VAT rate differentials. Moreover, using a common methodology over several countries and several years allows the comparability across geographies and time of these estimates to be improved.

On average, economy-wide TCPs are positive in LAC and have recovered following the reversion of the exceptional measures taken in response to the 2022 energy price shock. These positive TCPs are mainly driven by fuel excise taxes, which raise the prices of fuels and, hence, indirectly increase the cost of the associated CO₂ emissions, despite the offsetting effect of subsidies on these price signals. Direct carbon taxes are comparatively small (or null in several countries). Estimates for 2024 suggest that the economy-wide TCP in most LAC countries is nearly on par with the levels prevailing before the 2022 fuel price shock. This confirms that most countries have completed the reversion of exceptional subsidies and tax exemptions approved in response to the spike in energy prices in 2022.

Still, economy-wide TCPs remain below US\$60 per ton of CO₂, which is a common reference of global carbon costs in the literature. While the appropriate target for the carbon price needs to reflect specific circumstances in each country, this suggests that the current combination of energy taxes and subsidies leads, on average, to insufficient price signals to incentivize a reduction in emissions.

Moreover, because indirect price instruments are much more important, the impact of the fiscal system on fuel prices is not well aligned with the carbon content of each fuel, creating disincentives for energy transformation and climate mitigation. The estimated fuel-specific TCPs in this report suggest there are three key misalignments common across the region. These are affecting diesel, natural gas, and liquefied petroleum gas (LPG). Diesel emissions are taxed at comparatively lower rates. Lower diesel prices create perverse incentives for old, inefficient vehicles to remain on roads and inhibits the adoption of viable low carbon alternatives, such as electric buses. Natural gas is either untaxed or subsidized in most countries. This creates risks of technological lock-in because this could become a significant barrier to the adoption of renewable electricity and also lead to excessive dependence, given that the region is already a large natural gas importer. Typically used by households for cooking and heating purposes, LPG is also frequently subsidized. This policy has been traditionally adopted to encourage the use of relatively cleaner fuels by poorer, rural households (transitioning away from firewood and coal), but it is an inefficient spending measure (because these subsidies are not well targeted) and creates barriers to the expansion of residential electrification in LAC.

Increasing and aligning energy taxes to carbon content can generate needed revenue and reduce emissions, while growth impacts appear to be manageable. Results based on the Climate Policy Assessment Tool suggest that reforms that gradually increase the TCP to

US\$60 per ton of CO₂ by 2030 could increase tax collection by 0.5 percent to 1.0 percent of gross domestic product (GDP) in 2030. The range would reflect the varying conditions across countries. The multipliers of these reforms (that is, the decline in GDP for every 1 percent of GDP raised) are estimated at around 0.5 for a gradual rise in taxes. These multipliers seem potentially lower than those for other tax instruments, such as general VAT, but caution is required because there is evidence the multipliers depend on the starting point and cyclical conditions of countries, and the empirical literature is still limited. Additionally, the simulations suggest that these reforms would result in large reductions in greenhouse gas emissions that would put countries closer to the achievement of their Nationally Determined Contribution targets. Thus, in countries needing to close a fiscal gap, elimination of fuel subsidies or increases in fuel taxation appear to be potentially viable policy alternatives. In countries in which the fiscal space allows revenue recycling, simulations suggest that revenue recycling could offset most of the negative activity impacts of carbon price increases, while still resulting in significant emission reductions. Because the multiplier effects of energy taxation depend on economic conditions (the economic cycle, international oil prices, trade exposure, and so on), careful design and timing are critical. Moreover, for political viability, microeconomic impacts are as important as macroeconomic effects.

Sectoral roadmaps identifying complementary actions can maximize the effects of energy tax and subsidy reforms and their likelihood of success. A strategy based exclusively on energy taxation is prone to face economic and political resistance, given its sectoral impacts. In the transport sector, for example, gradual increases in diesel taxes might be accompanied by actions that incentivize investments in charging infrastructure, the acquisition of more efficient vehicles for freight transport, the adoption of electric buses, and measures to promote changes in transport modes. In the case of natural gas, reforms of electricity markets (both short-term dispatch and entry by new investors) to accelerate the integration of cheap variable renewables are key to allow households and industries to benefit from low-emission and competitive electricity. The reform of LPG subsidies needs to reflect the important role of LPG in substituting for solid fuels in poorer rural households. Steps could be taken to improve the targeting of these subsidies and widen the scope of support to include the electrification of household energy use. A common characteristic of these sectoral roadmaps is that they would provide, jointly with TCP reforms, an impulse to the modernization of these sectors, with positive consequences for long-term growth beyond the climate impacts.

Understanding the welfare and distributional impacts of TCP reforms is crucial for the effective implementation of the reforms. Aligning fuel tax rates with the associated fuel emissions and increasing the average TCP in a country causes a negative income shock among most households in the short term. The magnitude depends on household spending patterns, the country's economic structure, and the current energy tax and subsidy configuration. Simulations using the Commitment to Equity methodology in six countries (Brazil, Jamaica, Mexico, Paraguay, Peru, and Uruguay) find that the analyzed TCP reforms reduce per capita income by 0.1 percent to 1.2 percent on average in the short term, a modest effect. Even the most ambitious reform considered (raising the TCP to US\$60 per ton of CO₂ on all fuel emissions) negatively affects household income less than the average annual inflation rate in these countries in 2014–19. However, the effect could be larger in the case of reforms that set the TCP at a higher benchmark (e.g., US\$120 per ton of CO₂) or for countries with substantial fuel subsidies (e.g., Bolivia, Colombia, Ecuador), as such reforms would lead to larger price shocks. It is also important to

note that the estimates presented in this study do not account for the behavioral response of households to price changes, nor do they consider general equilibrium and long-term effects of the TCP reforms.

Average impacts mask important disparities: TCP reforms are largely paid for by wealthier households, though they disproportionately affect those at the bottom of the income distribution, particularly in the case of LPG reforms. Gasoline taxes have been found to have the largest average impacts, but tend to matter less among poorer households, whereas the opposite holds for LPG taxes, which are thus more regressive. This has important implications for TCP alignment reforms. Overall, for the countries analyzed, the estimated increase in poverty rates and decline in the middle class does not exceed 0.6 percentage points across the reforms analyzed, although, in populous countries, this means that hundreds of thousands could fall into poverty or vulnerability. The income effect of TCP reforms on poor and vulnerable populations are partially offset if they are accompanied by an expansion in existing social assistance benefits, while still preserving energy price signals. However, the efficiency and effectiveness of these complementary policies depend on having well-targeted programs in place. Additionally, these policies do little to compensate other population groups, who could be particularly affected and opposed to the reforms.

Overall, aligning energy taxes with each fuel's carbon content not only reduces emissions, but is a sound macroeconomic and technological policy, and, if accompanied by appropriate policies, it can have modest poverty and inequality impacts in the short term. Despite the strong technological and fiscal focus of this report, the fundamental recommendation it provides matches the standard climate policy guidance to align energy taxation with CO₂ content. There are two reasons for this. First, given the current stage of technological development, low-carbon technologies provide the most potential for a pro-growth transformation of energy systems, in a way that fossil fuels cannot. Second, subsidies and low taxes favoring fuel energy are a poor use of public resources in countries with other and more important fiscal priorities. *The adoption of a TCP framework is thus warranted not only for the climate impact, but from a broader development perspective.*

1

USING TOTAL CARBON PRICES TO DRIVE A TRANSFORMATION IN ENERGY SUPPLY AND DEMAND IN LAC



Energy systems, macroeconomic performance, and development are inextricably connected.

Energy production and use are essential for economic activity. From a physical perspective, no transformation of human effort into goods and services can occur without the use of energy. The improvement in the way energy is obtained and transformed into practical action through the development of equipment and skilled techniques is arguably at the core of the development of modern economies. The technological paths leading to this transformation are evident in every sector. For instance, in agriculture, the tractors of today routinely deliver the power of 10 or more tractors of the 1920s, which were able to replace 25 horses in agricultural tasks, while the energy required to produce a ton of ammonia with current methods is approximately two-thirds of the requirements of the first processes. The application of more powerful and more efficient machinery and processes is behind the industrial development of heavy industry: the energy requirements to produce a ton of iron in a modern mill are a third of the requirements in the early 1900s. Electric furnaces can convert the iron into steel with half the energy input of the 1950s, and the energy content of a ton of aluminum has been reduced by more than two-thirds since the first industrial applications of aluminum (Smil 2017).

Even in high technology applications, the implications of energy requirements and their relation to productivity are highly relevant.

Koomey's Law describes a trend in computing hardware whereby the number of computations per unit of energy used has been doubling every 1.5 years (Koomey et al. 2011). This means the amount of computing power available hence is expanding exponentially without a parallel increase in the energy requirements of the information technology sector. At the same time, the exploitation of fossil fuels has permitted the production of large quantities of energy at rates never witnessed before in history. The complexity of technological transformation does not admit of reductionist explanations. Technologies evolve for many reasons, not all related to energy. But these examples highlight the intrinsic connections between the improvements in humanity's capacity to produce goods and services and the production and use of energy. Growing energy availability is enhancing production capacity, while limitations on the availability of energy is restricting human potential (Ayres et al. 2013; Smil 2017; Stern 2011). At shorter horizons, energy is one of the most relevant factors in macroeconomic outcomes over the business cycle. Shocks to the prices of energy commodities drive inflation and its volatility, influencing monetary policy decisions and financial markets. This was most recently observed in 2022 after the prices of natural gas in Europe rose dramatically. Shocks to energy prices influence the fiscal situation of countries with large fossil fuel extraction sectors and the current account of importer countries. They have large effects on consumer behavior through their impacts on fuel prices and their indirect effects on overall prices.

The taxation or subsidization of energy has a dual role in modern economies, including in LAC countries.

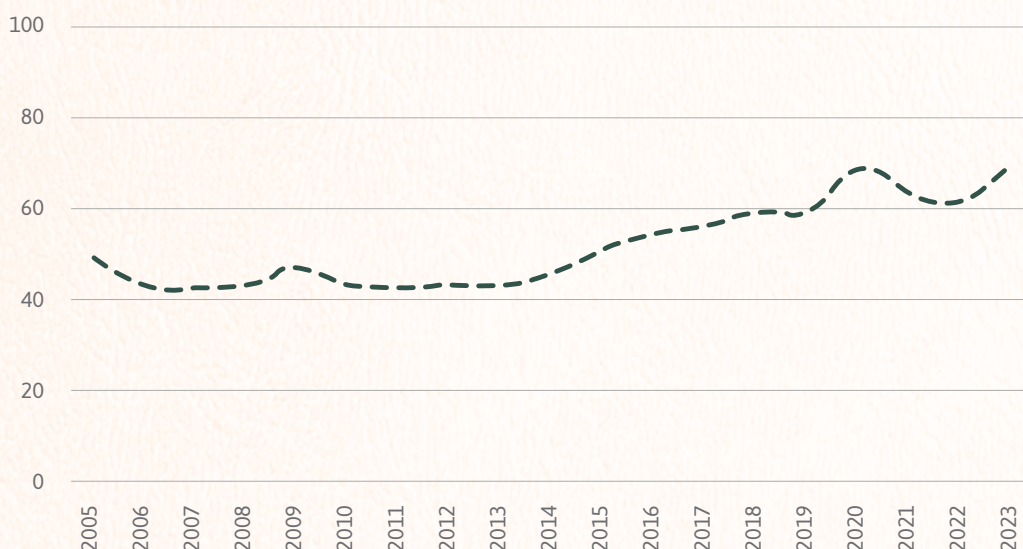
A wide variety of taxes and subsidies have historically been applied across the energy sector, covering every step of the energy process, from the extraction and distribution of fossil fuels to the use of these fuels in the industry, transportation, electricity generation, and residential sectors and in the acquisition of vehicles, cooking equipment, and more. In recent years, new fiscal instruments have emerged, such as carbon taxes, emission trading systems (ETSs), and pollution charges. LAC countries are no exception. These countries have historically raised significant revenue from energy taxation and continue to do so, while also spending substantial amounts on energy subsidies, frequently employing both approaches simultaneously, although targeting different fuels and user groups.

The use of fiscal instruments serves a dual purpose in modern economies. The first purpose is purely fiscal: energy is a significant source of revenue for governments. This is, in reality, the historical explanation for energy taxes. Governments across the world have considered energy consumption as an attractive revenue pool, easy to track, and characterized by low elasticity of demand. In producer countries, taxing extraction activities (or establishing government-owned monopolies) has provided and still provides in many cases a significant share of public revenues. The second purpose is more complex: taxing and subsidizing energy represent a key lever to achieve a wide variety of policy objectives. Energy taxes and subsidies are implemented to influence how agents use energy and, indirectly, how the economy operates. Subsidizing certain fuels, for instance, is often justified as an instrument to promote industries, to lower inflation, or to protect poorer households. These objectives are frequently poorly defined, and the suitability of energy taxes and subsidies to achieve them is also questionable, particularly because energy taxes and subsidies have a large inertia: once adopted, they prove difficult to change.

The context in which LAC countries manage their fiscal and energy policies is evolving rapidly. While debates around energy taxes and subsidies are far from new, taxing energy is now an even more strategic issue among the countries in the LAC region. A key message of this report is precisely that governments in the region need to reconsider how they tax and subsidize energy, because their current policies are increasingly misaligned with the environmental, technological, and economic landscape. Five key forces are reshaping the energy and fiscal landscape in the region, as follows:

- **The region must seize the opportunities presented by the new energy economy.** Throughout the twentieth century, reliance on fossil fuels, particularly oil and natural gas, dominated the energy landscape, while nuclear and renewables remained secondary. However, the twenty-first century is witnessing a shift toward a new energy economy focused on clean, low-carbon electricity. Innovations in solar and wind technologies have broken or are in the process of breaking the barrier of financial viability against fossil fuel technologies, driving a shift in the dynamics of energy supply (IEA 2024a, 2024b). Since 2016, investments in clean energy have surpassed those in fossil fuels. Solar photovoltaic investments alone outpaced investments in oil production in 2023. This success has spurred innovation in areas such as battery storage and hydrogen. The LAC countries stand to benefit significantly from this transformation if they actively participate in these technological developments and position themselves in the emerging global energy landscape, particularly by leveraging their abundant hydropower and renewable resources (World Bank 2022b).
- **The region needs to close the fiscal gap.** In recent years, particularly after the Covid-19 pandemic, most countries in the region have experienced a significant deterioration in public finances (refer to figure 1). Debt is, on average, 26 percentage points above the level of 2010, and fiscal deficits remain high. Carving fiscal space is a priority in most countries in the region (World Bank 2024b). Revisiting the way LAC governments tax and subsidize energy can generate much-needed fiscal resources. The potential benefits extend beyond fiscal accounts. For instance, by reducing fossil fuel imports, governments could improve the current account balance and reduce the exposure to commodity price shocks. Properly designed stabilization funds could ensure that revenue from fossil fuel exports is channeled into diversifying the sources of growth and strengthening the foundations for future sustainable and inclusive development.

Figure 1. Government debt, LAC average, percent of GDP



Source: Authors' calculations based on the World Bank's World Development Indicators (WDI).

- Relative to universal energy subsidies, well-targeted social protection programs can more effectively address social needs.** While equity and poverty concerns have traditionally been an important justification for energy subsidies, there is growing recognition that subsidies often fail to target vulnerable households efficiently (Mukherjee et al. 2023). In the context of the current fiscal constraints, governments in countries such as Colombia and Ecuador have begun to question the allocation of vast amounts of fiscal resources for fuel subsidies while other social needs are more pressing. Energy subsidies, prevalent in many LAC countries, are usually costly and inefficient, and they disproportionately benefit higher-income segments of the population. With advances in the design and implementation of social protection programs across the region, more well targeted instruments are available to achieve equitable outcomes. Moreover, fuel subsidies pose the risk of perpetuating the dependence of poorer households on fossil fuels and delaying household energy transition. Given these factors, there is an urgent need to rethink the approaches to addressing energy affordability and the role of energy subsidies in the region.
- The geopolitics of energy are changing.** Since World War II, the geopolitical implications of energy and global trade have been shaping the modern world (Yergin 2020). Rising geopolitical tensions are prompting major economies to reassess energy strategies, moving away from the open market approach that characterized the early twenty-first century. This shift is evident in the challenges involved in enforcing energy trade restrictions against Iran and Russia, the growing competition for minerals critical to the energy transition, and the rise in trade disputes within green industries. Governments in the LAC countries must adapt their energy strategies to these new realities. Many of these countries are key suppliers of critical minerals for the energy transition and are sought-after partners in the green industrial strategies of China, Europe, and the United States. Oil-producing nations must face the risk of losing oil revenues because of global decarbonization, while fossil fuel-importing countries are struggling to maintain energy stability amid the heightened international tensions.

- **The region has important decarbonization commitments and must react to global climate policies.** Climate change is a critical challenge. The effects in the LAC region are expected to be acute. Most LAC countries have set ambitious decarbonization targets as part of their commitments under the Paris Agreement. Decarbonizing energy use is a condition for achieving these targets. At the same time, governments must consider the climate policies adopted by others in designing their own policies, such as the European Union's Carbon Border Adjustment Mechanism, which imposes import tariffs based on carbon price differentials.

A total carbon price (TCP) framework represents an opportunity for governments in the region to rethink energy taxes and subsidies. In view of current trends, the LAC countries would benefit from a significant revision of the way they tax and subsidize energy. They might shift away from schemes that have often been developed reactively and without a clear strategic direction and toward a scenario in which fiscal instruments are designed explicitly to support broader objectives in energy system transformation, fiscal sustainability, social equity, geopolitical strategy, and climate ambition. This report uses TCPs as the guiding metric for setting energy taxes and subsidies. In a nutshell, TCPs measure the combined effect of the fiscal system on the relative price of each fossil fuel expressed in terms of the respective CO₂ content. TCPs thus measure the amount by which fiscal instruments increase or decrease the price of the CO₂ emissions generated by each fuel.

The TCP framework emphasizes the importance of using taxes to align the price of fuels with their emission content. Analyzing TCPs is important because steering the transformation of energy sectors without providing adequate price signals will prove impossible or more costly than necessary. TCPs provide a comprehensive perspective on the effects of fiscal instruments on energy prices. There are many instruments influencing energy prices. Considering only some of them (formal carbon taxes or ETSs, for example) can lead to biased decisions. Understanding the TCPs of fuels is the first step in a more fundamental reform program. This report argues that aligning price signals to the carbon content of each fuel and ensuring that TCPs are sufficiently high are sound and useful policy principles not only for the achievement of climate goals, but also for the broader goal of modernizing LAC energy systems. The main elements of the TCP framework in energy policy are detailed in the following subsections.

1.1. Energy prices at the center

A TCP framework emphasizes the role of prices in driving energy systems and the transformation of these systems. While various factors shape consumer and firm decisions regarding energy use, empirical evidence shows that prices are the most important driver of energy-related choices. Given that taxes and subsidies have a substantial effect on energy prices, the TCP approach highlights the importance of ensuring that these fiscal instruments provide price signals in line with energy goals and, more broadly, with overall development goals.

Fiscal instruments are an important determinant of energy use and supply through their impact on energy prices. In a typical country, total economy-wide expenditure on energy generally ranges from 7 percent to 10 percent of gross domestic product (GDP) (Grubb et al. 2018). Tax revenues or subsidies of approximately 1 percent of GDP, which are on the

lower end of regional estimates, imply that these fiscal instruments account for at least 10 percent to 15 percent of the overall energy expenditure of a country. This effect is particularly pronounced in the case of certain fuels because taxes and subsidies tend to be concentrated on a few of these.

Energy prices affect the intensity of energy use, that is, the amount of energy used per unit of output. Economies respond to rising energy prices by reducing their reliance on energy inputs in both production and consumption processes. Empirical evidence at the macrolevel documents the strong negative correlation between energy prices—particularly carbon prices—and energy intensity in, for example, Australia, Canada, the European Union, the United Kingdom, and the United States (Arlinghaus 2015). Firm-level studies in the literature also find a statistically significant negative relationship between energy prices and energy intensity. Thus, a 1 percent increase in energy prices leads to energy efficiency improvements of 0.5 percent among Mexico’s manufacturing firms and 0.23 percent among Indonesia’s (Pigato 2019). This reduction in energy use occurs in the intensive and extensive margins, that is, respectively, within agents and across agents. The intensive channel operates at the level of households or individual firms, which reduce their energy needs per unit of output, driving improvements in energy efficiency. For instance, Amann and Grover (2023) find that larger Chilean firms increase capital investment and productivity in response to oil price shocks, while smaller firms show less flexibility. The extensive channel, on the other hand, occurs if sectors or firms with higher energy demands become less prominent in the economy in response to an increase in energy prices.

Prices also influence the energy mix used by households and firms, which must decide how much energy to use, but also which energy sources to choose. This decision is complex because different forms of energy exhibit variations in suitability for different purposes. As a result, the degree of substitutability among energy sources depends on the specific application. For example, electricity can be a viable substitute for the combustion of fossil fuels in applications that require moderate or low temperatures. Research shows that relative prices significantly impact the energy mix across sectors because economic agents shift toward more cost-effective energy sources. Households, for instance, often swap among cooking and heating fuels in response to price signals, such as the observed change from firewood to liquefied petroleum gas (LPG) in response to subsidies. In transportation, the LAC region offers several examples of alternative fuel adoption. Brazil thus leads the world in the use of ethanol, driven by policies that substantially lowered the relevant price. A critical sector for fuel switching is electricity generation, where the relative prices of oil, natural gas, and coal affect generation costs compared with renewables. As a result, power producers adjust operations to adopt the most cost-effective options, which impacts the transition to cleaner electricity.

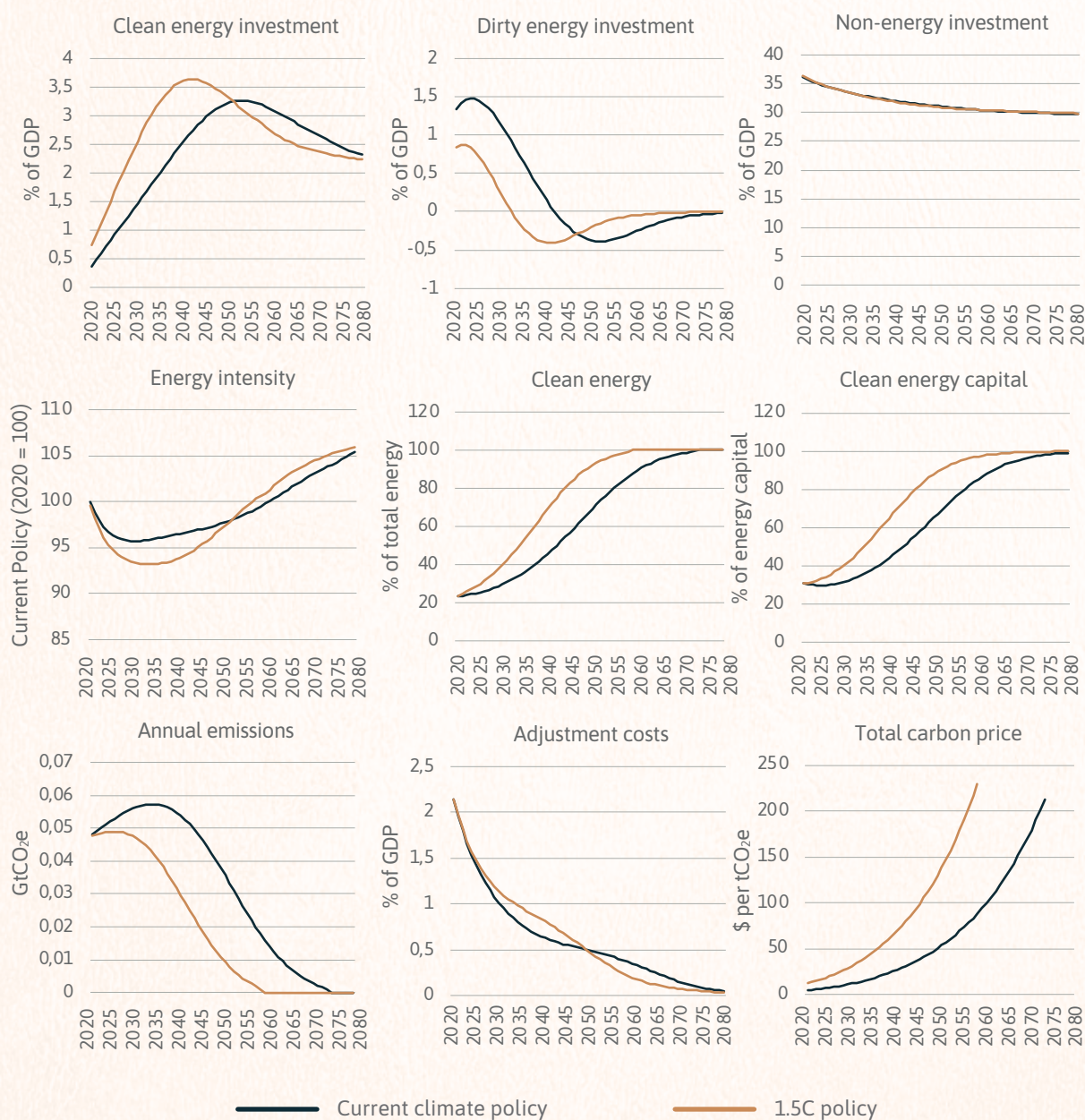
Energy prices play a significant role in shaping capital investment decisions related to energy. Processes involving energy production and use often require important up-front investments, such as purchasing vehicles, boilers, and furnaces. Similarly, adopting low-carbon electricity requires investments in generation capacity, transmission infrastructure, and the electrification of industrial and transport sectors. These investment decisions are, in part, guided by expectations of future energy prices as much as by current prices. For households, the cost of cooking stoves can hinder the shift from solid fuels, so that they will only change

if future prices of LPG, electricity, or natural gas are attractive. In transportation, more fuel-efficient vehicles often require a higher up-front cost, and recovering that premium through fuel savings depends on whether diesel is cheap or expensive. In electricity generation, the trade-off is critical. Renewable technologies, such as wind and solar, have high initial costs, but no fuel expenses. Whether they are financially more attractive is therefore highly dependent on the cost of the fuels used in other electricity generation technologies.

A calibration of the general equilibrium growth model in Göth, Zessner-Spitzenberg (2024) for a typical LAC country illustrates the effects of higher energy prices on energy intensity, composition, and investment (refer to annex A for technical details on the model). In this model, energy is a mix of both high- and low-emitting sources, the production of which requires capital. A simulation of an increase in the price of high-emitting energy sources because of higher taxation leads to a significant reduction in energy use per unit of output (lower energy intensity), an increase in the share of low-carbon energy sources in total energy expenditure (cleaner energy mix), and a shift in investment toward these energy alternatives (cleaner energy investment) (refer to figure 2).

Setting taxes and subsidies so that prices send the right signals is essential in transforming energy systems. Because prices have a central role in the decisions of agents regarding energy, policies aimed at transforming energy systems are unlikely to work if prices are not sufficiently aligned with the intended goals. Hence, reforming taxes and subsidies to achieve this alignment is a necessary condition for successful energy policy. Pursuing green energy strategies in contexts in which subsidies provide a strong incentive for using fossil fuels is unlikely to deliver the expected result or will require the costly oversizing of policies that offset the advantages the fiscal systems provide to fossil fuels.

Figure 2. Total carbon pricing incentives on investment in the energy transition



Sources: World Bank elaboration based on Burda, Göth, and Zessner-Spitzenberg 2025; Göth and Zessner-Spitzenberg 2025; Göth, Zessner-Spitzenberg, and Fischer 2025.

Note: The figure depicts the simulated optimal path of several macroeconomic variables in an average Latin American country according to the current climate policy scenario (blue) and the optimal path according to the climate policy scenario compatible with reaching 1.5°C globally (orange). Energy intensity is shown as energy in (model) quantities, divided by output in (model) quantities, normalized by the current policy scenario in 2020. Adjustment costs as a share of GDP are defined as the sum of the sector-specific convex costs of capital adjustment on net investment in the clean and dirty energy sectors and the nonenergy sector at each point in time, over model units of output at each point in time. For more details on the model, refer to annex B.

1.2. Aligning energy prices with CO₂ emissions

Fuel prices need to reflect the cost (including the social cost) of the associated CO₂ emissions to foster a transition toward low-carbon energy systems. Fossil fuels are one of the main sources of energy globally, but their combustion results in the emission of carbon dioxide (CO₂) and other harmful pollutants. The TCP approach facilitates the implementation of a uniform price on CO₂ emissions from fuel combustion to account for the negative externalities. Expressing the impact of fiscal instruments on fuel prices in terms of their CO₂ emissions is crucial to generating country-level estimates and enabling cross-country, cross-fuel, and over time comparisons, but also to ensuring that these instruments capture the societal costs of emissions in a consistent way, providing the adequate signals for the transformation of energy systems. Providing consistent carbon price signals across different fuels is essential to supporting the transition to low-carbon energy systems. A uniform price on CO₂ emissions incentivizes economic agents to shift to low-emission energy sources and to adopt key low-carbon energy technologies. Pricing fossil fuel emissions is essential to unlocking the full benefits of low-carbon technologies.

The TCP approach is based on the principle that taxes on fuels should be aligned with the CO₂ emissions content of the fuels. Because energy taxes and subsidies have not been designed with reference to carbon content, their effects on the price of emissions can differ substantially across fuels. Thus, taxes and subsidies result in different TCPs for different fuels. For instance, it is common across LAC countries that certain fuels have a positive TCP, but others have a negative TCP, implying that CO₂ emissions from certain energy sources are taxed, while the emissions from others are effectively subsidized, thereby incentivizing the use of the sources. Moreover, the TCP of fuels, even if it is positive, can frequently be much lower than what would be required to provide an adequate incentive for the transformation of energy systems and to account for all the costs of CO₂ emissions.

The benefits of strong and consistent carbon price signals go beyond climate mitigation. While reducing greenhouse gas emissions is undoubtedly a key benefit of setting adequate carbon prices and one that economists have emphasized more frequently, the transformation of energy systems that could be achieved with adequate carbon price signals is likely to provide other substantial advantages to LAC economies. The modernization of vehicle fleets and the changes in transport modes associated with a reduction in the subsidies for transportation fuels, for example, would enhance LAC productivity, while also generating important health benefits. The increased penetration of variable renewable energy technologies in the electricity sector of LAC would lower the dependence on expensive fossil fuels in many countries. Reducing fossil fuel subsidies would allow scarce fiscal resources to be redirected to more productive uses with higher positive long-term impacts. In summary, the benefits can be substantial and go beyond the fulfillment of environmental goals in LAC, including benefits associated with the broader transformation of energy systems and fiscal sustainability.

1.3. A comprehensive bottom-up approach

Effective fiscal policy design should reflect the combined impact of all fiscal instruments on energy prices. Policy decisions on energy taxation need to account for all price-based fiscal instruments that directly or indirectly influence energy price signals, emphasizing the importance

of considering these instruments simultaneously (Agnolucci et al. 2023, 2024). Excise taxes, which are typically imposed as a fixed amount per unit of energy or volume, are prevalent across the LAC region, much as in other regions. Carbon taxes, which are based on a charge per unit of greenhouse gas emissions, have been adopted in several countries, but remain relatively small in scale. As of now, no ETS system has been established in any of the LAC countries analyzed. Additionally, many governments have implemented special value added tax (VAT) regimes for energy, whereby lower or higher VAT rates affect the relative price of energy compared with other goods and services subject to the standard VAT rate. Furthermore, these taxes often coexist with various subsidy measures that reduce the relative price of fuels. The subsidies may take multiple forms, including direct payments to consumers, compensation to producers for selling fuels below cost, sectoral or regional tax exemptions, and price-setting rules by national energy monopolies that do not prioritize profit maximization. This creates a mix of effects on energy prices and emissions, and different fiscal instruments reinforce or offset each other and exert different impacts depending on the energy source.

TCPs measure the net impact of the fiscal system on energy prices. The TCP approach prioritizes economic impact over legal form. What matters is the ultimate impact on energy prices, not whether the impact is achieved by an excise tax, a carbon tax, a price control, or an explicit subsidy (refer to table 1) (see also Campmas et al. 2024). Because different fiscal instruments are defined in varying units, to aggregate their impact and compare across fuels, the TCP metric is normalized by the CO₂ emissions content of each fuel. For example, a gasoline excise tax of US\$0.10 per liter is equivalent to a carbon price of US\$45 per ton of CO₂ because burning one liter of gasoline releases approximately 0.0022 tons of CO₂ into the atmosphere (refer to box 1 for more details on the TCP methodology). This principle is grounded in the theory of optimal taxation, which posits that fuels should be taxed to account for the externalities they generate. Although these externalities extend beyond carbon emissions alone, using CO₂ as a benchmark offers a clear, transparent measure. Also, it is directly aligned with low-carbon technological innovations and climate policy objectives, making it a practical standard for evaluating and addressing the broader impacts of fuel use.

Table 1. Direct and indirect priced-based fiscal instruments considered in the TCP metric

Focus	Price-based instruments
Direct	Carbon tax (+)
	Emissions Trading Systems average marginal price (+)
	Tradable performance standard (+)
Indirect	Fuel excise tax (+)
	Producer-side subsidies (–) ^a
	Consumer-side subsidies (–)
	VAT deviation from standard rate (exemption or reduced rate) (–)

Note: A positive (negative) sign means that the fiscal instrument results in an increase (decline) in energy prices.
a. Producer-side subsidies are included only if they affect the final prices of energy. For internationally traded fuels in economies with no export restrictions, producer-side subsidies are expected to affect producer profitability, but not necessarily final prices.

This metric is calculated for each fuel to assess the relative price effects and then aggregated across fuels to obtain a country-level TCP estimate. For each fuel, the TCP or effective carbon rate is calculated by expressing all fiscal interventions in US dollars per commercial unit (for instance, per liter), adding them, and then applying the appropriate conversion factors to express the sum in US dollars per ton of CO₂. A positive TCP indicates that the fiscal system increases the price of the analyzed fuel compared with a fully neutral fiscal system (that is, one in which fuels are taxed exactly as any other good or service in the economy); the higher the TCP, the higher this effect. A negative TCP, on the other hand, indicates that the fiscal system reduces the price of the fuel, thereby incentivizing the use of the fuel. Because some fiscal instruments apply only to certain uses, such as transport, the TCP can be decomposed by sectors. A country-level TCP is then calculated as the weighted average of fuel-specific TCPs, with weights given by the share of each in total CO₂ emissions.

Box 1. Total Carbon Pricing Methodology

Adding up the impact of all fiscal instruments for fuel f in year provides an estimate of the net tax burden per unit of fuel f in a given country, as follows:

$$Net\ tax\ burden_{tf} = DTB_{tf} + ITB_{tf} \quad (B1.1)$$

The net tax burden consists of the combined impact of direct and indirect carbon pricing instruments. Direct carbon pricing instruments (DTB_{tf}) include carbon taxes and emission trading systems (ETs), which directly impose a price on CO₂ emissions. The indirect tax burden (ITB_{tf}) includes instruments that affect the price of fuels in ways that are not directly proportional to the associated emissions. These indirect instruments are grouped into three categories: fuel taxes (ET_{tf}), such as excise taxes, fuel subsidies (FS_{tf}), and value added tax (VAT) differentials with respect to the general rate ($vat_{sub_{tf}}$), as follows:

$$ITB_{tf} = ET_{tf} - FS_{tf} - vat_{sub_{tf}} \quad (B1.2)$$

A positive net tax burden means that the government generates revenue from the analyzed fuel, while a negative net tax burden indicates that the government spends more on the fuel than it collects through taxes on the fuel.

The case of gasoline in Peru may illustrate how the net tax burden is calculated. In Peru, gasoline is subject to an excise tax of US\$0.06 per liter and a special ad valorem tax of 8 percent on the cost of supply. In addition, Peru has a fossil fuel price stabilization fund (Fondo de Estabilización de Precios de Combustibles), which, in 2016–23, resulted in net government expenditure because international prices fluctuated above the established bands.

$$\begin{aligned}
 \text{Net tax burden}_{\text{gasoline, 2022}} &= \underbrace{0.06 \frac{\$}{\text{liter}}}_{\text{excise tax}} + \text{Supply cost (0.96 \$/liter)} * \underbrace{0.08}_{8\% \text{ special road tax}} \frac{\$}{\text{liter}} \\
 &\quad - \underbrace{0.0026 \frac{\$}{\text{liter}}}_{\text{Subsidies:}} \\
 &\quad \text{net compensations from the FEPC} \\
 &= 0.14 \text{ \$/liter}
 \end{aligned} \tag{B1.3}$$

To calculate the total carbon price (TCP) of a fuel, the net tax burden needs to be converted into units of emissions generated by that fuel (US dollars per ton of CO₂). This requires fuel-specific emissions factors, which account for the amount of CO₂ emitted per unit of fuel. For example, the combustion of one liter of diesel releases about 2.7 kilograms of CO₂ into the atmosphere, whereas gasoline combustion releases 2.2 kilograms of CO₂ per liter.

The TCP for fuel f in year t is the sum of the direct (DCP_{tf}) and indirect (ICP_{tf}) tax burdens expressed in CO₂ terms, as follows:

$$TCP_{tf} = DCP_{tf} + ICP_{tf} \tag{B1.4}$$

A positive TCP indicates that the fiscal system raises the price of the fuel above the market price. In contrast, a negative TCP means the fiscal system reduces the fuel price, implying that the fuel is subsidized.

Fuel-specific TCPs are then summed and weighted according to the relevant CO₂ emission shares in the country to estimate the country-level total carbon price (TCP_t). Emission shares are adjusted to account for the use of biofuels, as follows:

$$TCP_t = \frac{1}{\text{emissions}_t} \sum_f TCP_{tf} \times \text{emissions}_{tf} \tag{B1.5}$$

A positive countrywide TCP indicates that, overall, the country imposes a price on fuel-related emissions. A negative countrywide TCP implies that the country subsidizes fossil fuel use and, consequently, CO₂ emissions. However, such an aggregate might hide significant variations across different fuel types. If a country has both positive and negative TCPs at the fuel level, this implies that the carbon pricing signals are misaligned. For a guide on the TCP methodology also see Campmas et al. 2024.

In this report, the TCP metric is calculated using a bottom-up approach. The TCP estimates are based on an in-depth analysis of each country's fiscal system. Each instrument is examined separately using local data sources, where possible. The TCP estimates involved gathering granular data on taxes, fees, subsidies, and prices related to each fuel. Information is gathered for instruments at the local, state, and national levels. The TCP metric is calculated for fuels because they are the sources of carbon emissions. An important caveat is that this version of TCP estimates does not include separate values for electricity. Electricity emissions are the consequence of fuel combustion in power generation plants, and the estimates presented do account for tax exemptions and so on if they apply to the input fuels used in the generation sector. However, this version of the TCP does not account for situations in which electricity is itself subject to specific taxes, exemptions, or subsidies. This is therefore an area for future improvement.

The TCP estimates in this report may differ from other, related indicators and concepts in the literature. The concepts behind TCP estimation have been developed by several researchers. The effective carbon rate of the Organisation for Economic Co-operation and Development (OECD) is the closest to the TCP concept described above. Three main differences distinguish the two approaches: (1) the OECD does not account for VAT deviations, which are common in LAC countries; (2) the OECD does not consider local taxes; and (3) the OECD definition of subsidies does not consider certain government price controls in some countries. Another, related approach is the one used by the International Monetary Fund (IMF), although it focuses on the estimation of both implicit and explicit fuel subsidies (IMF 2021; Parry, Black, and Roaf 2021; Parry, Black, and Zhunussova 2022). The IMF defines implicit subsidies as the difference between the price of the fuel and the total social cost, which combines the supply cost, the environmental (emissions) costs, and the broader externalities associated with fuel use, such as air pollution, traffic congestion, and road wear. In the case of explicit subsidies, the IMF uses a top-down approach that is applied only if final fuel prices are below the estimates of a fair supply price. Positive differences between final prices and the supply price using the IMF methodology cannot be interpreted as positive carbon prices. For instance, it may be that fuel prices are above the fair supply price by US\$0.10 per ton of CO₂, but it is impossible to attribute this to a specific policy action (an excise tax and so on) or simply to a measurement error in the fair price. Beylis and Cunha (2017) apply the price gap approach to various Latin American and Caribbean countries.

2

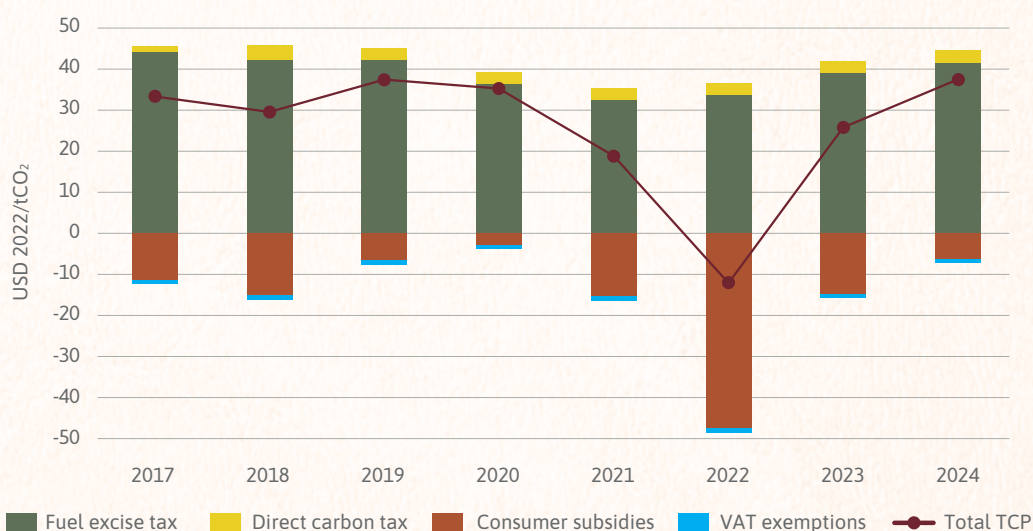
INSIGHTS FROM TOTAL CARBON PRICES IN THE LAC REGION



2.1. The price of fuel-related CO₂ emissions in the region is positive, on average

The overall carbon price on fuel emissions in the LAC region is positive. From 2017 to 2024, the net effect of taxes after accounting for subsidies created a positive wedge in the price of CO₂ in most countries. The average TCP for the sample of 10 countries on which this indicator was estimated (weighting the TCP of different fuels by the emission shares) was positive in 2017–21 (refer to figure).¹ It became negative as a consequence of the temporary steps adopted in reaction to the global increase in energy prices in 2021–22, but has now recovered to the previous level. The estimated TCP in the region in 2024 was US\$37.5 per ton of CO₂, only marginally below the highest value recorded in 2019, US\$37.6 per ton of CO₂.

Figure 3. The average TCP in the LAC region, by type of fiscal instrument



Sources: World Bank calculations based on local data sources; WEB (World Energy Balances) (dashboard), International Energy Agency, Paris, <https://www.iea.org/data-and-statistics/data-product/world-energy-balances>; WEO (World Economic Outlook Databases) (dashboard), International Monetary Fund, Washington, DC, <https://www.imf.org/en/Publications/SPROLLS/world-economic-outlook-databases#sort=%40imfdate%20descending>. Note: The LAC regional average TCP by type of fiscal instrument is calculated as the weighted average of country-specific and instrument-specific TCPs, by the share of each country's CO₂ emissions over total LAC CO₂ emissions (only including the sample countries and fuels under study). TCP values for 2024 for Argentina, Chile, Colombia, Mexico, and Uruguay are estimated using data up to August 2024. For the other countries, data for 2024 are assumed as constant at 2023 values. Dominica and St. Lucia do not appear because their respective share of CO₂ emissions over total LAC emissions are very small. Data on emission shares are built by using the International Energy Agency (IEA) WEB energy consumption data (which goes up to 2022; so 2022 values are taken as constant in 2023 and 2024) and converted into emissions using IEA's conversion factors for most countries, with the exception of Dominica, Paraguay, St. Lucia, and Uruguay, where emission data are taken from national sources. Argentina and Mexico account for the largest shares of CO₂ emissions in the sample, 21 percent and 49 percent of the total, respectively.

1 The countries are Argentina, Chile, Colombia, Dominica, Jamaica, Mexico, Paraguay, Peru, St. Lucia, and Uruguay. Data for Brazil were estimated only for 2017, 2022, and 2023 and can be found in Fleischhaker, Navia and Rios (2024).

However, there is wide dispersion in country-level TCPs across the region. If expressed in constant 2022 US dollars per ton of CO₂, the TCP estimates reveal substantial differences. For instance, in 2023, the aggregate TCP was negative, at –US\$20.00 per ton of CO₂ in Colombia, compared with a positive TCP of US\$51.47 per ton of CO₂ in Uruguay in the same year. Interpreting these cross-country comparisons is not straightforward because of composition and valuation effects. Because the country-level TCP is a weighted average of fuel-specific TCPs, two countries may have similar country-level TCPs and yet be characterized by different taxation structures across fuels. Also, because the taxes and subsidies included in the TCP calculation are set by governments in local currencies, exchange rate valuation effects can have a significant impact on the TCP results.

TCPs are driven mostly by indirect carbon pricing instruments, particularly fuel excise taxes and fuel subsidies. In line with the results of Agnolucci et al. (2023, 2024), in the LAC countries, indirect fiscal and quasi-fiscal instruments included in the TCP methodology are found to have a much larger influence on the total price of emissions, given their larger coverage and higher rates relative to direct carbon pricing instruments (that is, explicit carbon taxes and ETs) (refer to figure 3). Several countries in the region do not rely on direct carbon pricing instruments at all, such as Paraguay and Peru, and still achieve positive TCPs. Even in the countries where these direct pricing instruments are used, such as in Argentina, Chile, Colombia, Mexico, and Uruguay, they still represent a comparatively small fraction of the aggregate TCP in the region.

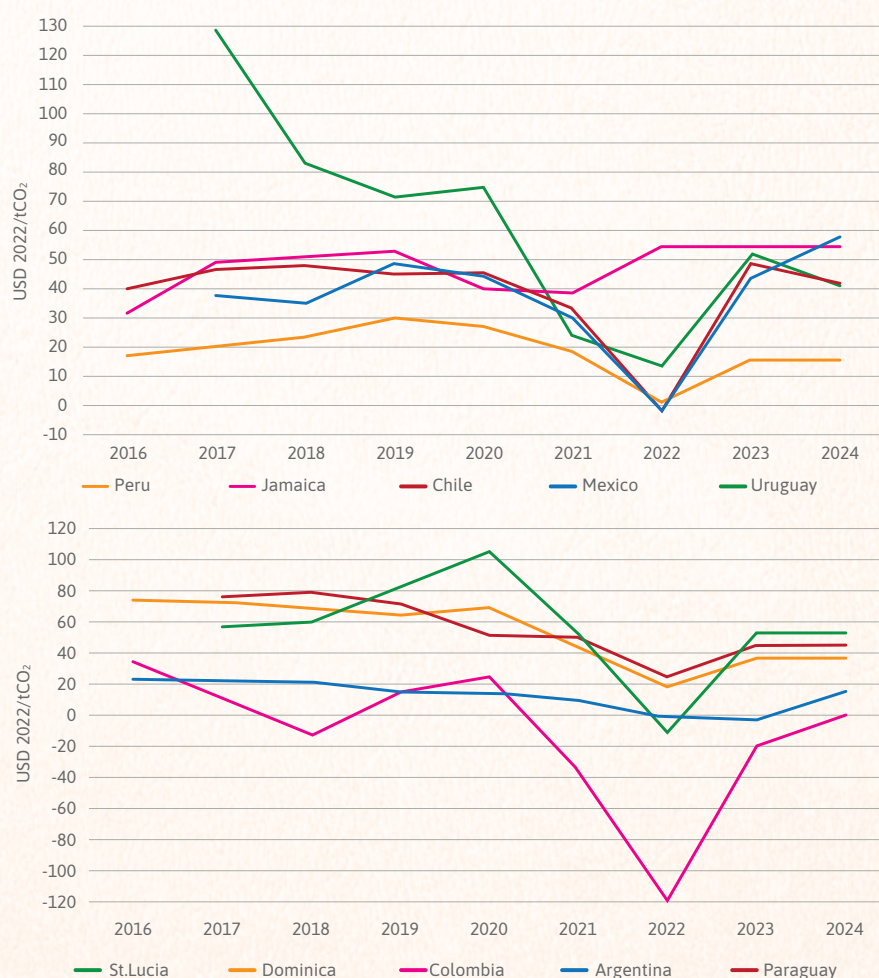
Fuel subsidies are widespread, pushing TCPs downward. These subsidies are present in 8 of the 10 countries evaluated in this study, and, in these countries, they coexist with fuel excise taxes and carbon taxes. The largest subsidies are in Colombia, which offered an average annual subsidy of US\$35 per ton of CO₂ in 2016–24, followed by Argentina and Mexico, with average annual subsidies of US\$14 per ton of CO₂. On average in the region, fuel subsidies offset the impact of fuel excise taxes by around 40 percent. In fact, the LAC TCP would be 1.6 times higher if these subsidies were removed. While the effect of VAT exemptions and reduced rates on the regional TCP is relatively small, these measures play an important role in certain countries, such as Dominica, Paraguay, St. Lucia, and Uruguay.

2.2. There is scope to raise TCPs

Each government's choice of a target carbon price needs to consider a combination of domestic and global factors. Theory suggests that, in the absence of market failures and restrictions on the trade of emission reductions, the price of carbon should be uniform across countries (Stern, Stiglitz, and Taylor 2022). However, these conditions are rarely met in LAC countries, meaning that carbon prices need to be adapted to each country's circumstances and objectives. For example, the relative abundance and availability of cheaply accessible renewable resources (such as hydropower, solar, and wind) suggest that even a moderately size carbon price could drive significant shifts in the energy matrix toward lower-carbon options. In contrast, factors such as higher financing costs for renewables and barriers to technology adoption require higher carbon prices to incentivize the energy transition and emissions reduction. Other factors influencing the choice of TCP include macroeconomic, fiscal, equity, and political considerations. Additionally, the uncertainty surrounding the economic transformation needed for decarbonization, along with the difficulty in determining the true social cost of CO₂ emissions, presents important challenges (Alatorre et al. 2019). Further research on the adequate price of carbon at the national level is required.

The estimates in this study indicate that there is scope to raise carbon prices in countries across the region to account more effectively for the externalities of CO₂ emissions and support the energy transition. Preliminary estimates for 2024 suggest that TCPs are below US\$42 per ton of CO₂ in more than half the LAC countries under study, lower than the estimated cost of the damage caused by the emission of a ton of CO₂ and insufficient to meet the targets set by the Paris Agreement (OECD 2023). Frequently cited studies suggest prices around of US\$60 per ton of CO₂ as more adequate, providing a commonly used reference (Kaufman et al. 2020; OECD 2023). Among the 10 countries analyzed, only Jamaica, St. Lucia and Mexico priced CO₂ emissions close to the US\$60 per ton of CO₂ benchmark in 2024. Estimates suggest that, in 2024, about 23 percent of CO₂ emissions from fuel combustion remain unpriced in the countries covered in this study.²

Figure 4. Trends in TCPs, selected LAC countries



Sources: World Bank calculations based on local data sources; WEB (World Energy Balances) (dashboard), International Energy Agency, Paris, <https://www.iea.org/data-and-statistics/data-product/world-energy-balances>; WEO (World Economic Outlook Databases) (dashboard), International Monetary Fund, Washington, DC, <https://www.imf.org/en/Publications/SPROLLS/world-economic-outlook-databases#sort=%40imfdate%20descending>.

Note: A country TCP is the weighted average of each fuel by the share of the fuel's emissions in the country's total CO₂ emissions.

² Note that this statistic is based on IEA emissions data and therefore does not include Saint Lucia and Dominica in its calculation. However, the combined emissions from these countries account for less than one percent of the total emissions across the analyzed countries.

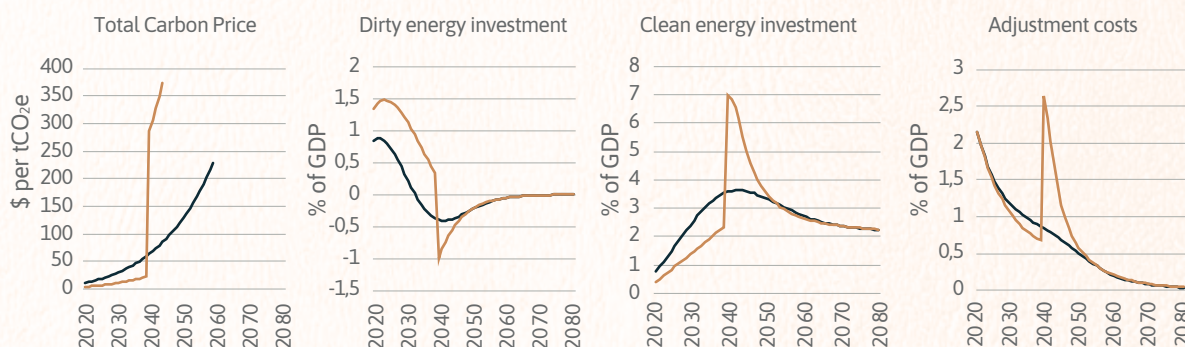
Several countries in the region are already taking steps in the direction of increasing carbon pricing. Various initiatives point to an acceleration in the adoption of stricter carbon pricing policies through both direct and indirect carbon pricing instruments. For instance, in Brazil, the recent VAT reform will result in the uniform taxation of fuels across states (whereas several states previously applied lower VAT rates on fuels), and the implementation of an ETS is advancing through legislative and administrative processes. Ecuador has recently enacted a fuel subsidy reform focused on gasoline and LPG that will partially correct the country's large negative price on emissions from fuel combustion³. Argentina⁴ has also started to correct the distortions in energy pricing that have been pervasive. Peru has launched a consultative process to identify the implications and potential uses of carbon pricing in the economy, and the government has removed LPG from the fossil fuel stabilization fund. In Colombia, gasoline's consumer subsidies from the Fuel Price Stabilization Fund were removed and the carbon tax increased in 2024. Also, it is expected that this tax will gradually apply to coal starting in 2025, and the debate around the elimination of the diesel subsidy has gained prominence.

The predictability of energy taxation and carbon prices is important in maximizing their efficiency. The visibility and credibility of the policy commitment to increasing TCPs are essential to avoiding large economic disruptions. As emphasized in this report, agents react to carbon signals through changes in energy intensity, composition, and investment decisions. Changes in intensity and composition can occur to a certain extent without changes in investment, but there are important costs involved. A firm that faces an abrupt, unexpected increase in the price of energy will react by reducing output in the short term (rather than by technological change or other adaptation actions). Unpredictable carbon pricing prevents the gradual adaptation of the economy through the investment channel. However, if agents can foresee changes in carbon prices, their capacity to adapt and invest in alternative technologies improves, minimizing the adjustment costs of carbon pricing.

The costs of transition in terms of stranded assets and adjustment costs rise drastically if carbon pricing is not implemented in a predictable way. The importance of predictability can be illustrated using the model of Burda, Göth, and Zessner-Spitzenberg (2025) and Göth, Zessner-Spitzenberg, and Fischer (2025) to simulate a scenario whereby carbon pricing is delayed, and then a sudden and unexpected policy reversal is required to achieve emissions reduction goals (refer to figure 5). A regime switch in 2040 would be especially costly because an immediate price increase to almost US\$300 per ton of CO₂ equivalent would be necessary to achieve emission reductions consistent with the 1.5°C goal. Unpredictable carbon prices cause overinvestment in fossil-based energy, leading to large amounts of stranded assets and substantial costs of adjustment. More fossil-based energy assets are stranded because the unpredictable tax change encourages overinvestment in fossil-based energy in the beginning and prevents early investments in clean energy capital. The sudden shift in energy use that would be required later would generate large adjustment costs in 2040–50.

3 Note that Ecuador is not included in the sample of countries used in this study.

4 TCP estimates for Argentina do not include the effect of price regulations known as the "barril criollo". If included, the TCP estimate for 2016 and 2017 would be US\$9/tCO₂ higher on average, and US\$8/tCO₂ lower on average for the period 2018 to 2024. This price intervention ended in 2024.

Figure 5. The impact of a predictable carbon price on the transition path

Source: World Bank calculations based on Burda, Göth, and Zessner-Spitzenberg 2025; Göth and Zessner-Spitzenberg 2025; Göth, Zessner-Spitzenberg, and Fischer 2025.

Note: Adjustment costs as a share of GDP are defined as the sum of the sector-specific convex costs of capital adjustment on net investment in the clean and dirty energy sector, as well as the nonenergy sector at each point in time over model units of output at each point in time. For more details on the model, refer to annex B.

Even where technological development may require investments to be delayed, a gradual commitment to carbon pricing helps to prepare policy actions. In some sectors, such as steel production, that have higher technology disadvantages in the case of low-emission technologies, the LAC countries may benefit by delaying some investments until technologies mature and global learning and scale effects lower the costs. Even in these cases, committing to increasing carbon prices in the future still creates the rationale for investors to plan to switch to low carbon investment in the appropriate timeframe. Using a committed gradual strategy still enables the economy to rely on the investment channel and guide investment into the clean energy sector.

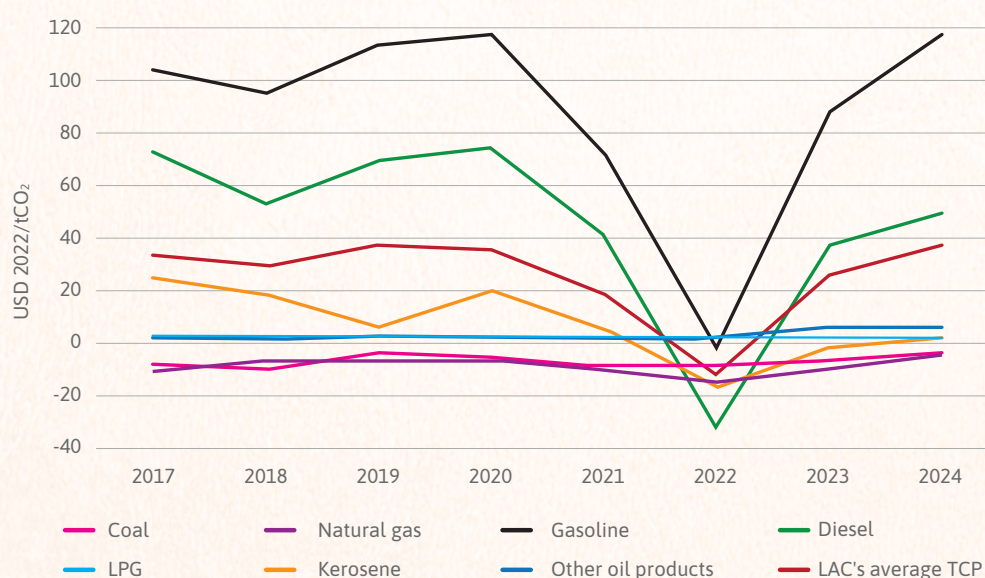
2.3. Indirect pricing instruments are not aligned with fuel emissions

Indirect price instruments, such as excise taxes and subsidies, are not well aligned with the carbon content of each fuel. An important difference between direct and indirect carbon pricing instruments is that the former align the impact of the fiscal system on fuel prices with fuel emission content because they are defined per ton of CO₂ emitted, whereas the latter do not necessarily accomplish this. For instance, an economy-wide carbon tax of US\$100 per ton of CO₂ would increase the price per unit of natural gas to about half that of coal because natural gas combustion produces roughly half the CO₂ emissions of coal. In contrast, an excise tax of US\$100 per unit of energy on both natural gas and coal would increase the retail price of both fuels by the same amount. Therefore, while a uniform carbon tax creates financial incentives for households and firms to use lower-emission energy sources, excise taxes do not. Similarly, subsidies for specific fuels would lower the price of these fuels relative to other fuels, regardless of the relative carbon contents. Because excise taxes and subsidies are the main components of TCPs in the LAC region, their misalignment with emissions means that TCPs do not provide a consistent carbon price signal across emitting sources.

To understand the price signals and incentives that energy taxes and subsidies, the composition of TCP across fuels is critical. Heterogeneous TCPs across fuels generate inconsistent price signals to economic agents, affecting energy use and supply decisions. Improving the alignment of fiscal instruments with the emission content of each fuel is an important lever in the design of fiscal and energy policies. Full alignment to carbon emissions does not necessarily need to be the goal of energy taxation reform, but it remains the case that, in most countries, improving the alignment would result in stronger incentives to steer the energy system toward more energy efficiency (hence, higher economic productivity), lower dependence on fossil fuels, more rapid adoption of renewable energy from domestic sources, and a corresponding shift in investment flows. This combination seems a better fit for the energy and development needs of most countries in the region. Hence, it is important to understand the impact of the biases in the TCPs of different fuels, whether they are justified and whether there are alternative policy options to achieve positive outcomes in terms of development without sacrificing important energy transition goals.

Three patterns of misalignment are commonly observed across the region: (1) diesel emissions are priced considerably below the price of gasoline, (2) emissions from natural gas are generally untaxed or subsidized, (3) emissions from LPG are frequently subsidized (refer to figure 6). These are described in more detail in the next paragraphs.

Figure 6. Average LAC TCPs, by fuel



Sources: World Bank calculations based on local data sources; WEB (World Energy Balances) (dashboard), International Energy Agency, Paris, <https://www.iea.org/data-and-statistics/data-product/world-energy-balances>; WEO (World Economic Outlook Databases) (dashboard), International Monetary Fund, Washington, DC, <https://www.imf.org/en/Publications/SPROLLS/world-economic-outlook-databases#sort=%40imfdate%20descending>. Note: The aggregate TCP for the LAC region for all fuels is the weighted average of fuel TCPs based on the emission share of each fuel in total regional LAC emissions (only including the sample countries and fuels under study). TCP values for 2024 for Argentina, Chile, Colombia, Mexico, and Uruguay are estimated using data up to August 2024. For the other countries, data for 2024 are assumed as constant at 2023 values. Dominica and St. Lucia do not appear because their respective share of CO₂ emissions over total LAC emissions are around 0 percent. Data on emission shares are built by using the IEA WEB energy consumption data (which goes up to 2022; so 2022 values are taken as constant in 2023 and 2024) and converted into emissions using IEA's conversion factors for most countries, with the exception of Dominica, Paraguay, St. Lucia, and Uruguay, where emission data are taken from national sources.

First, gasoline typically has the highest TCP in most countries in the region (refer to figure 7). Its TCP has exceeded US\$75 per ton of CO₂ in most of the countries and years analyzed, with several of them—such as Chile, Jamaica, Paraguay, and Uruguay—reporting average prices above US\$100 per ton of CO₂. Excise taxes on gasoline are widespread and comparatively high in many countries, often serving as the primary instrument of carbon taxation across the economy. Gasoline prices are also affected by other fiscal instruments, including explicit carbon taxes. For example, Uruguay imposes a CO₂ tax that applies only to gasoline; Peru uses an ad valorem tax, the impuesto al rodaje, which applies exclusively to gasoline; and, in Brazil, many states applied, until the recent reform, a higher VAT (ICMS, Imposto sobre Circulação de Mercadorias e Serviços, tax on the movement of goods and services) on gasoline compared with the general rate.

Figure 7. Average TCP, by fuel and country, 2017–23



Sources: World Bank calculations based on local data sources; WEB (World Energy Balances) (dashboard), International Energy Agency, Paris, <https://www.iea.org/data-and-statistics/data-product/world-energy-balances>; WEO (World Economic Outlook Databases) (dashboard), International Monetary Fund, Washington, DC, <https://www.imf.org/en/Publications/SPROLLS/world-economic-outlook-databases#sort=%40imfdate%20descending>. Note: Averages are for 2017–23 given the lack of data on some countries in 2016 and 2024.

Second, diesel emissions tend to be priced below the price for gasoline emissions, and, in several countries, the TCP differential between the two fuels is substantial. On average, from 2017 to 2023, the TCP of diesel in the region was US\$46 per ton of CO₂, compared with US\$84 per ton of CO₂ for gasoline. Among the countries analyzed, only Dominica and St. Lucia have diesel TCPs higher than gasoline TCPs, while Jamaica and Mexico have a TCP for diesel that is around 90 percent of that for gasoline. In contrast, in Argentina, Paraguay and Peru, diesel TCPs are approximately 50 percent of the gasoline TCP, while, in Chile, and Uruguay, they range from 10 to 20 percent of the gasoline TCP. Similar to gasoline, the TCP of diesel is primarily driven by fuel excise taxes, but these are set at a lower rate, and, in some countries, diesel has specific subsidies implemented through price stabilization funds (such as in Colombia and Peru).

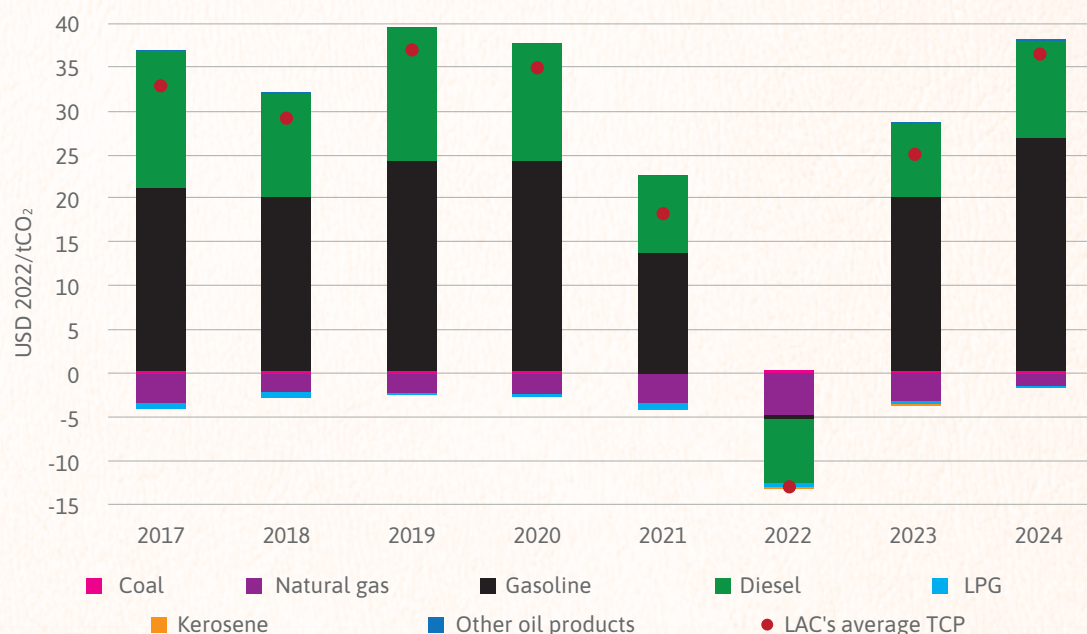
Third, emissions from natural gas are typically untaxed across the LAC countries, or they are even subsidized because of fiscal support measures encouraging them (refer to figure 7). Natural gas is not typically subject to fuel excise taxes, only to the general VAT rate. In practical terms, the only instances in the region where the fiscal system increases the price of natural gas are in countries that have explicit carbon taxes applied at the establishment level. This means that all CO₂ emissions from covered sites, including those from natural gas, are subject to the tax. Chile's carbon tax and the Mexican state-level carbon taxes are examples, though the rates are comparatively low. In parallel, several countries use different incentives to promote the adoption of natural gas technologies and subsidize natural gas consumption among low-income households. For instance, Peru subsidizes the connection of residential households in major cities to the gas pipeline network, while Argentina has subsidized its price and infrastructure. On average, the TCP of natural gas in the region is –US\$10 per ton of CO₂. Most countries have a carbon price that is essentially zero, except Argentina (average of –US\$25 per ton on CO₂) and Colombia (average of –US\$21 per ton of CO₂).

Similarly, most of the countries considered in this report subsidize the use of LPG, resulting in a negative TCP for this fuel (refer to figure 7). Consumer subsidies take the form of retail prices that are fixed below cost, whereby government absorbs the difference (the case in Colombia, Dominica, St. Lucia, and Uruguay), on top of which there are VAT exemptions in all of these countries, except for Uruguay. On average, between 2017 and 2023, 7 of the 10 countries analyzed exhibited negative TCPs for LPG. These negative rates are particularly pronounced in Colombia (–US\$124 per ton of CO₂), Dominica (–US\$34 per ton of CO₂), St. Lucia (–US\$212 per ton of CO₂), and Uruguay (–US\$196 per ton of tCO₂). Only Chile, Mexico, and Paraguay exhibit a positive net tax on LPG emissions, with rates below US\$3 per ton of CO₂.

The combination of these patterns explains why the positive regional TCP is primarily driven by gasoline. The contribution of fuels to the regional TCP is determined by the participation of the fuels in total CO₂ emissions and the net taxation levels of the fuels. Countries with higher emissions, such as Argentina and Mexico, have a greater weight in the regional TCP. Estimates show that, although natural gas accounts for the largest share of the region's CO₂ emissions (32 percent in 2022), it contributes negatively to the regional TCP, mostly because of consumer subsidies in some of the largest emitting countries (Argentina and Colombia) and a lack of taxation in the remaining countries. LPG also contributes negatively to the regional TCP, which is explained by the considerable subsidies and VAT exemptions across the board. While diesel accounts for almost the same share of emissions as gasoline (22.3 percent and 22.6 percent of

the total emissions studied, respectively), gasoline's positive contribution to the regional TCP is significantly higher, approximately two times that of diesel in 2024, because of the higher taxation on gasoline in all the countries analyzed (refer to figure 8).

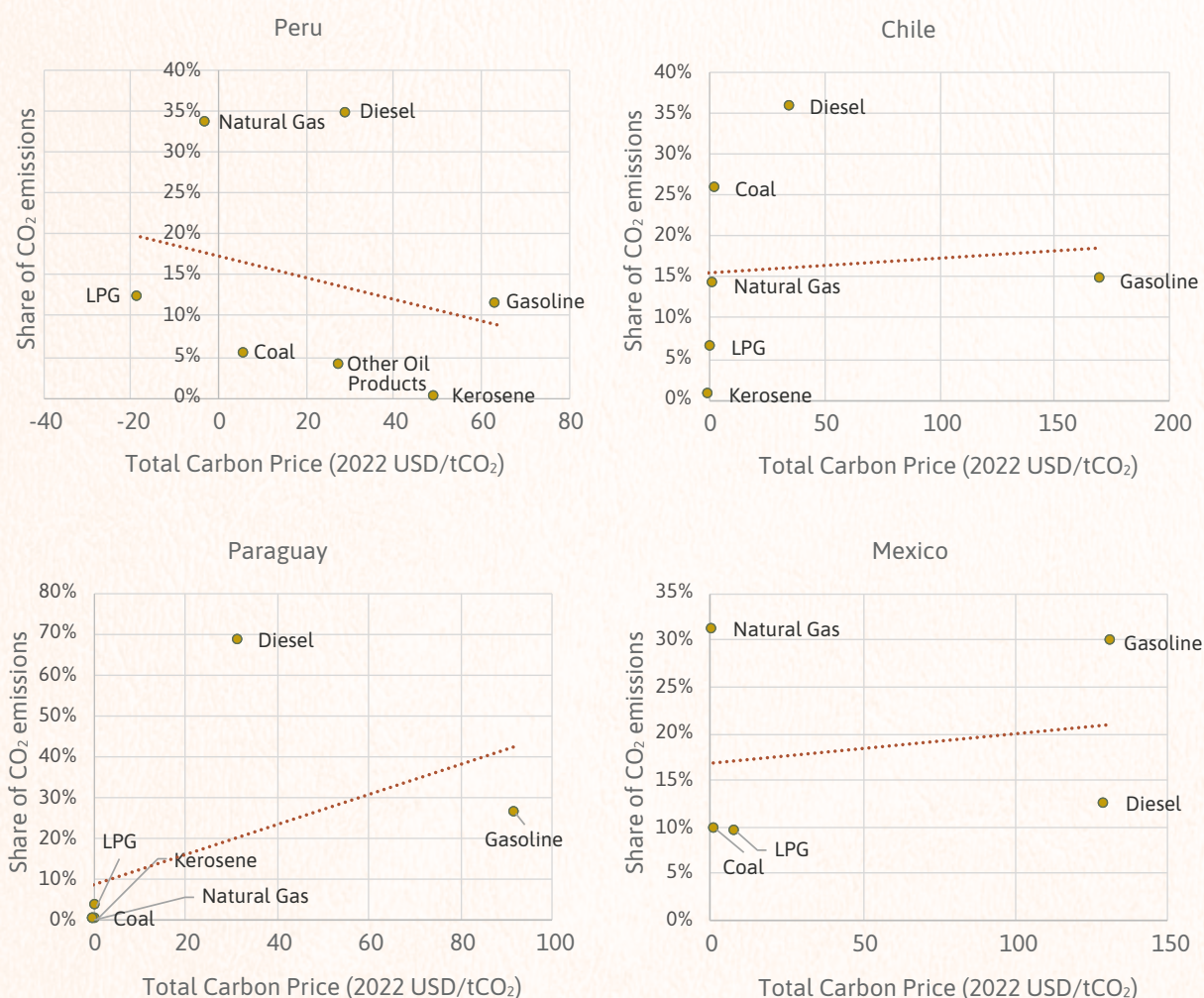
Figure 8. The contribution of the TCP of each fuel to the average regional TCP



Sources: World Bank calculations based on local data sources; WEB (World Energy Balances) (dashboard), International Energy Agency, Paris, <https://www.iea.org/data-and-statistics/data-product/world-energy-balances>; WEO (World Economic Outlook Databases) (dashboard), International Monetary Fund, Washington, DC, <https://www.imf.org/en/Publications/SPROLLS/world-economic-outlook-databases#sort=%40imfdate%20descending>. Note: The contribution is calculated by taking the values in figure 7, that is, the regional TCPs by fuel, and weighting them by the share of the regional CO₂ emissions for each fuel in total LAC emissions (including only the fuels and countries in the sample under study). The caveats described in the note to figure 6 apply.

Overall, in most LAC countries, fuels responsible for the largest share of emissions are those with the lowest TCPs. For instance, in Peru, the TCP of diesel in 2024— was 54 percent lower than the TCP of gasoline, while diesel was responsible for three times the share of emissions of gasoline (refer to figure 9). This is a self-reinforcing trend because a government tends to favor pricing cheaply those fuels on which the country is more dependent (and, so, the fuels that are more responsible for the country's emissions). However, as explained in the first section, this creates perverse incentives to increase the use of these same fuels, reinforcing the dependence on them and making price reforms increasingly more difficult over time. Breaking this vicious circle is a key policy challenge in the LAC region. The next section discusses the use of sectoral roadmaps to increase the chance of success in breaking the cycle.

Figure 9. Fuel-specific total carbon prices and the fuel share of total CO₂ emissions, selected countries, 2024



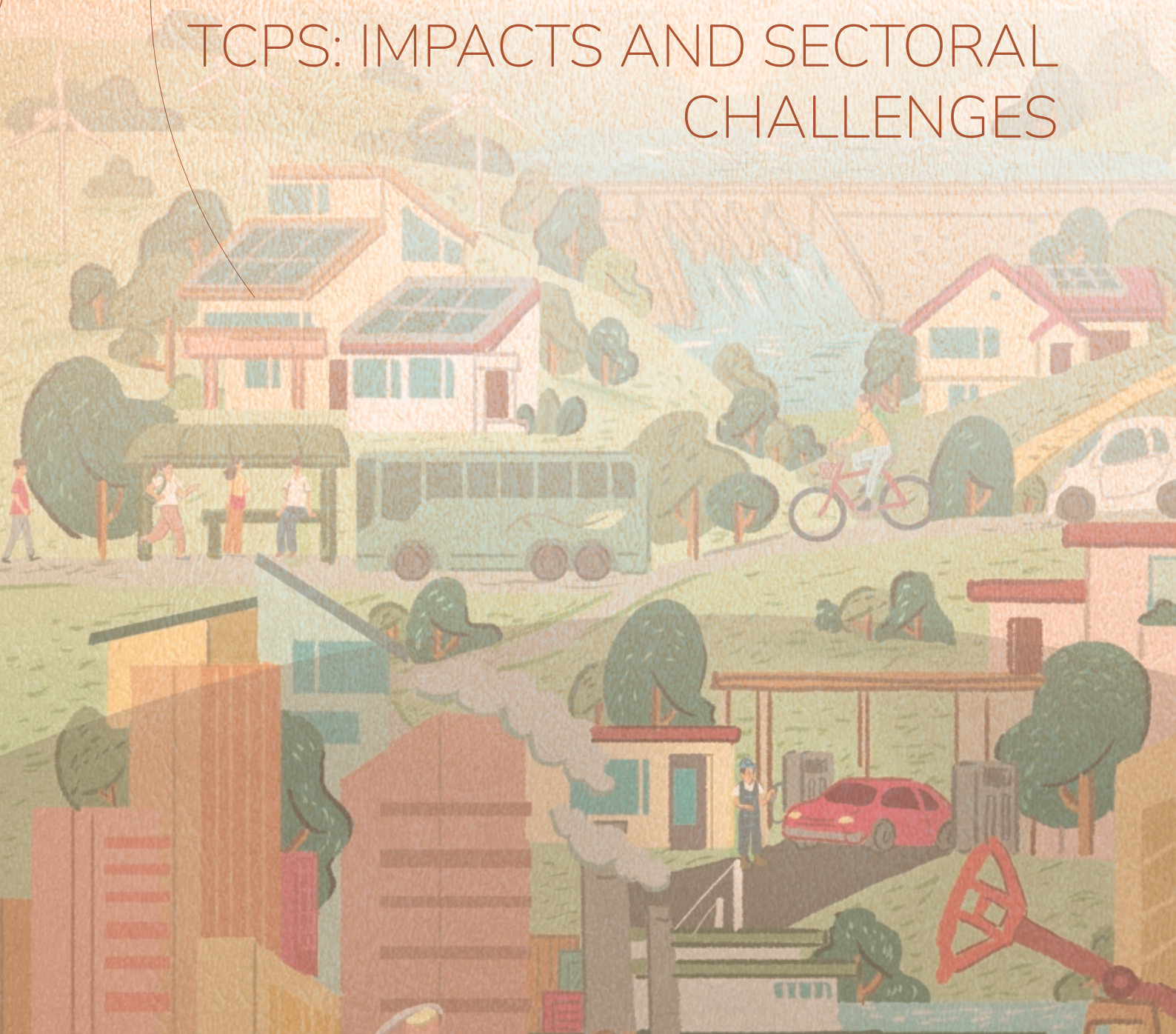
Sources: World Bank calculations based on local data sources; WEB (World Energy Balances) (dashboard), International Energy Agency, Paris, <https://www.iea.org/data-and-statistics/data-product/world-energy-balances>; WEO (World Economic Outlook Databases) (dashboard), International Monetary Fund, Washington, DC, <https://www.imf.org/en/Publications/SPROLLS/world-economic-outlook-databases#sort=%40imfdate%20descending>. Note: The figure shows fuel-specific TCPs by country in 2024. The values of 2022 are taken as constant to 2024 given the data availability issues affecting some countries.

It is not only about carbon emissions; policy reforms aiming to align energy taxation with emission content need to account for other externalities, too. Overall, correcting these carbon price misalignments should be an important goal in the design of energy-related fiscal instruments. However, this does not necessarily mean that TCPs should be fully equal across all fuels. Fuels generate other important negative externalities beyond greenhouse gas emissions. For instance, coal, wood, and diesel combustion release large amounts of

particulate matter into the air. These particles contribute to local air pollution, posing serious risks for human health. The use of transport fuels is also related to road accidents, traffic congestion, and road wear. However, policies are available to implement pricing schemes that directly target these other externalities. For example, insurance premiums that increase among drivers who engage in dangerous behavior are now being linked to drivers through mobile phone technology. Aligning fuel taxes with fuel CO₂ emissions remains a valid approach for providing a consistent carbon price signal across an economy, this approach could be combined with alternative policies or adjusted, in the case of particular fuels and depending on viability and technical conditions, to account for externalities beyond CO₂ emissions.

3

REFORMING ENERGY TAXES AND SUBSIDIES TO ENHANCE TCPS: IMPACTS AND SECTORAL CHALLENGES



Governments can affect the net taxation of energy sources through a combination of policy instruments. Reforms increasing the TCP encompass, for example, the introduction or expansion of direct carbon taxes, the elimination or reduction of fossil fuel subsidies and tax exemptions or differential VAT rates, and increases in the rates or coverage of fuel excise taxes, or any combination of these. As this report emphasizes, what is most relevant is the total, combined impact of all these instruments on energy prices. The term “total carbon price reforms” is used in this report to refer to this wide set of policies. To help illustrate the climate mitigation (reduction in emissions) and macroeconomic effects of TCP reforms, this section analyzes the impact of a gradual increase in the TCPs in a selection of countries (Colombia, Mexico, Paraguay, and Peru) using the Climate Policy Assessment Tool and considering various policy scenarios regarding the alignment of fuel TCPs and the recycling of fiscal revenues (refer to box 2).

Box 2. The Climate Policy Assessment Tool

The Climate Policy Assessment Tool is a spreadsheet-based model and aggregator of external models to inform environmental tax reform and carbon pricing efforts. It has been developed jointly by the World Bank and the International Monetary Fund.^a The tool helps decision-makers and analysts perform quick diagnostics on the potential benefits of explicit carbon pricing and fossil fuel subsidy reforms (Black et al. 2023). This is accomplished through reduced-form approximations used to estimate emissions, the concentration of pollutants, and health effects.

The tool is primarily a dashboard based on price and income elasticities. It models the change in energy consumption resulting from changes in carbon taxes by computing the impact the policy configuration may potentially have on the domestic prices of fossil fuels. Given these prices, it models energy consumption and the resulting greenhouse gas emissions from the consumption vector.

a. Refer to CPAT (Climate Policy Assessment Tool) (dashboard), International Monetary Fund and World Bank, Washington, DC, <https://www.imf.org/en/Topics/climate-change/CPAT>.

The policy reform scenarios evaluated in this section assume a gradual increase from each country’s starting TCP to a target level of US\$60 per ton of CO₂ by 2030. The countries start from their 2023 estimated TCP levels, described in the previous section. For example, Colombia starts with a nationwide TCP in 2023 of US\$ -20 per ton of CO₂, while Mexico starts at US\$43 per ton of CO₂. The target TCP of US\$60 per ton of CO₂ can be achieved in two different ways. The first option is that the TCPs of all fuels are aligned, and each reaches a level of US\$60 by 2030 (refer to annex figure D1). This implies an alignment of all tax and subsidy instruments and the emission content of each fuel. The second option is to allow different fuels to maintain different TCPs, keeping the initial dispersion, but then increasing them all until the countrywide TCP, which is an emissions-weighted average of the TCPs of all fuels, reaches the target of US\$60 per ton of CO₂ (refer to annex figure D1).

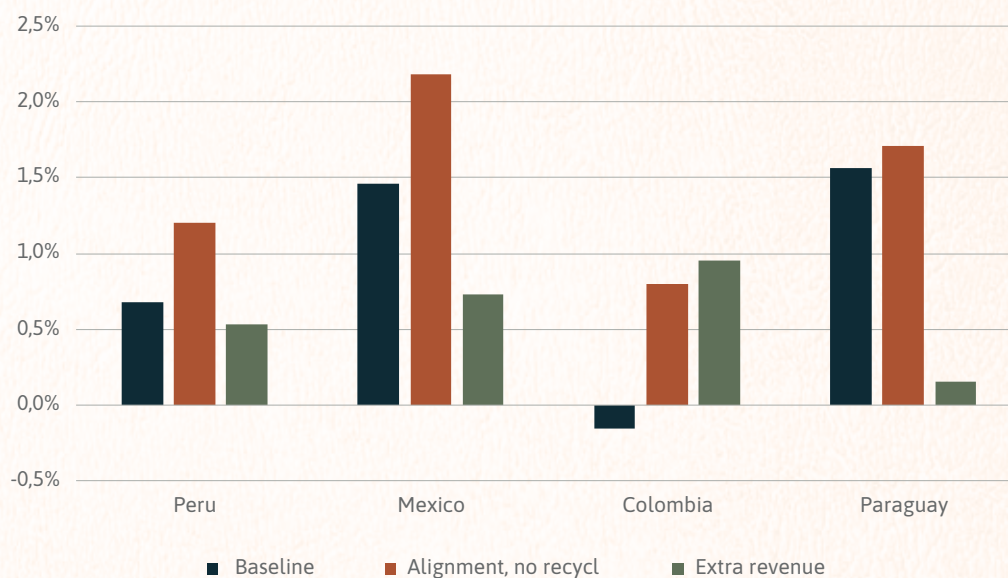
This latter scenario resembles a reform option consisting of adding a direct carbon tax to the existing fuel tax and subsidy structure, without applying any other changes. A price of US\$60 per ton of CO₂ is used here as benchmark because it is the midrange of the carbon price trajectory proposed by the High-Level Group on Carbon Pricing (Stern and Stiglitz 2021). This is an illustrative target, but, as explained elsewhere in this report, the determination of the appropriate carbon price will depend on the country's economic and social context. The scenarios analyzed assume the target US\$60 per ton of CO₂ price of carbon is achieved by 2030, following linear increases from 2024 to that year.

3.1. Macroeconomic impacts: fiscal revenue, economic growth, and CO₂ emissions

Increasing the economy-wide carbon price to US\$60 per ton of CO₂, while aligning all fuel TCPs with that level, would increase fiscal revenue by 0.2 percent to 1.0 percent of GDP in 2030 compared with the baseline scenario of no reform (refer to figure 10). The differences in revenue gains across countries are, in large part, driven by the initial economy-wide TCP dispersion in 2023. For instance, in the baseline scenario, Colombia has a negative nationwide TCP of –US\$20 per ton of CO₂. Thus, the model estimates that it could gain about 1 percent of GDP of extra revenue by raising the economy-wide TCP to US\$60 per ton of CO₂. The gains are comparatively smaller in Paraguay, which is starting from a higher TCP, US\$45 per ton of CO₂. The results are moderate in Mexico and Peru. Notice, however, that the effect on revenue is not proportional to the increase in the nationwide TCP. There are two main reasons for this. First, higher net taxation on emissions leads to a decline in economic activity and, thus, in the taxed emissions (assuming no revenue recycling, as is the case here). Second, the shift in the composition of energy driven by the change in TCP also lowers the emission intensity of each economy, thereby lowering the revenue from TCP instruments relative to a static exercise.

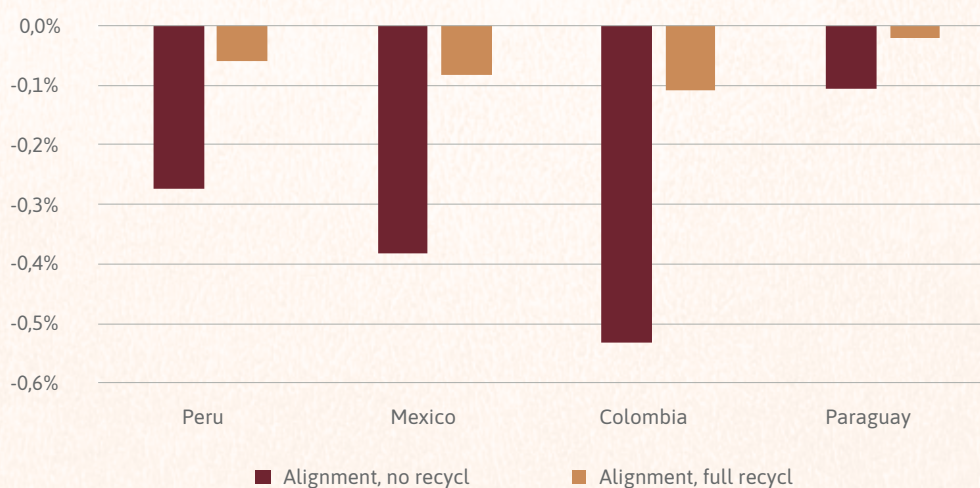
The reform, in the absence of revenue recycling measures, would lead to a growth reduction of 0.3 percent to 0.5 percent in 2030 compared with the baseline pathway. The gradual increase of the TCP to US\$60 per ton of CO₂ for all fuels would lead to a slowdown in GDP growth by 0.5 percent in Colombia, 0.4 percent in Mexico, and 0.3 percent in Peru, compared with the baseline scenario in that same year (refer to figure 11). Again, the differences in growth effects are explained by the starting point of each country's TCP and the emissions intensity in each country. Additional TCP revenue can also be used to fiscally consolidate, reducing public debt. Consequently, it would help reducing debt servicing costs which could also lower the negative impact on GDP growth. However, CPAT cannot account for these positive impacts since it is not a full general equilibrium model able to account for these endogenous effects. Introducing revenue recycling, via spending the additional carbon tax revenues equally on public investment and direct transfers reduces the negative growth in all countries to -0.1 percent or less.

Figure 10. Total fiscal revenue as a share of GDP under the baseline scenario (TCP fixed to the 2023 level) and the reform scenario (aligning the TCP of all fuels to US\$60 per ton of CO₂ in 2030 without revenue recycling)



Source: Simulations based on total carbon price calculations using data of CPAT (Climate Policy Assessment Tool) (dashboard), International Monetary Fund and World Bank, Washington, DC, <https://www.imf.org/en/Topics/climate-change/CPAT>.

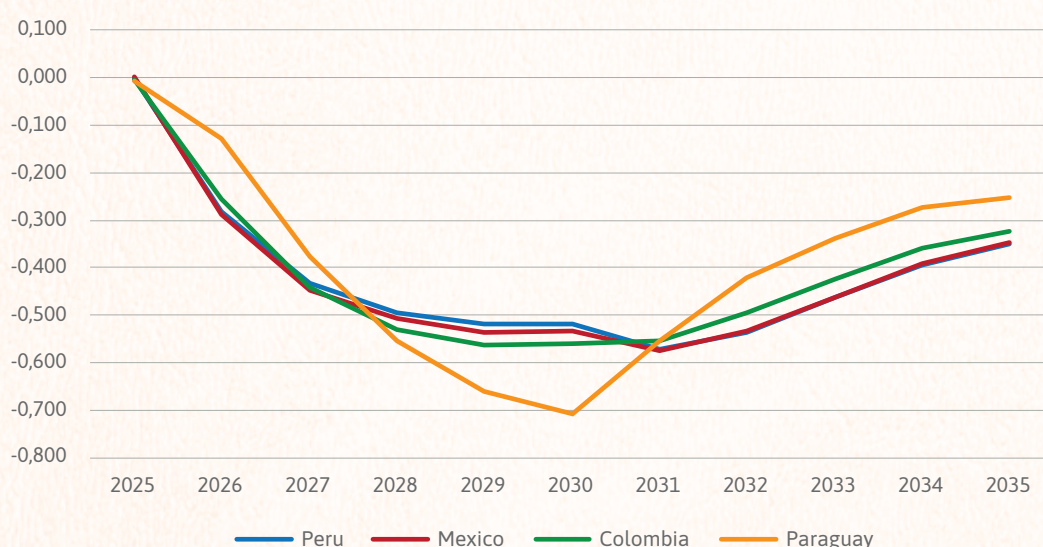
Figure 11. GDP growth reduction compared with the baseline in 2030 with and without revenue recycling measures



Source: Simulations based on total carbon price calculations using data of CPAT (Climate Policy Assessment Tool) (dashboard), International Monetary Fund and World Bank, Washington, DC, <https://www.imf.org/en/Topics/climate-change/CPAT>.

Increasing the TCP of each fuel uniformly to US\$60 per ton of CO₂ by 2030 suggests tax multipliers at between –0.5 and –0.7 in 2030 for the upper-middle-income countries under study (refer to figure 12). In Mexico, for example, an increase in tax revenue equivalent to 1 percent of GDP would result in a fall of –0.5 percent in GDP. The data presented here correspond to “point in time” multipliers. Given the current fiscal context in the region, countries may consider increasing the TCP as part of a broader fiscal consolidation strategy. However, in these situations, the practical question is likely to be whether the negative growth impacts of TCP reforms are manageable given the additional revenue they provide and their co-benefits in terms of emission reductions and other positive externalities.

Figure 12. Fiscal multiplier of a reform that sets a uniform carbon price of US\$60 per ton of CO₂ across fuels, without revenue recycling measures



Source: Simulations based on total carbon price calculations using data of CPAT (Climate Policy Assessment Tool) (dashboard), International Monetary Fund and World Bank, Washington, DC, <https://www.imf.org/en/Topics/climate-change/CPAT>.

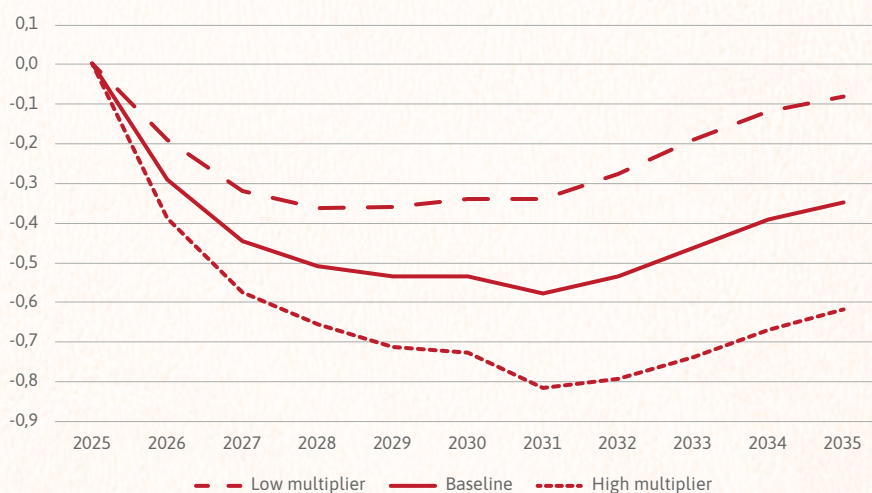
Note: Following Ramey (2019), the computation of fiscal multipliers is based on the new standardized approach, defined as the ratio of the change in output to the change in taxes that caused the change in output, as follows:

$$\left(\frac{\left(\left(\frac{GDP_{policy,t}}{GDP_{Baseline,t}} \right) - 1 \right)}{\left(Total\ revenue\ \% \ GDP_{policy,t} - Total\ revenue\ \% \ GDP_{Baseline,t} \right)} \right)$$

Evidence in the literature indicates that energy tax multipliers vary substantially depending on the economic conditions. Schoder (2023) finds that energy tax multipliers tend to be small and not statistically meaningful. However, the economic impact of energy taxes is more negative – hence fiscal multipliers are higher – when they are increased during economic downturns, fuel costs are elevated, or the when the taxes themselves are already substantial. According to his study, countries in which the economy is more sensitive to commodity trade face higher environmental tax multipliers than otherwise. In contrast, he finds that multipliers are lower if, upon implementation, the carbon intensity of GDP is higher,

suggesting that countries at the beginning of a decarbonization effort can expect lower multipliers. This is the case because, at that stage, governments still have more abatement options that are relatively easy to achieve. As a first approximation to this possible variability in the size of fiscal multipliers, figure 13 shows the 1 standard deviation confidence bands for the multipliers estimates used in the Climate Policy Assessment Tool simulations. Figure 13 suggests that an increase in TCP tax revenue equivalent to 1 percent of GDP would result in a fall of -0.35 to 0.7 percent in GDP. These findings indicate that energy taxes may offer a less restrictive means of generating revenue, particularly in nations that are in the early stages of transitioning to lower carbon emissions, compared with the effects of other revenue-enhancing fiscal instruments, such as value-added or income taxation.

Figure 13. Tax multiplier sensitivity to TCP 60, with alignment, no recycling, in a LAC middle-income country

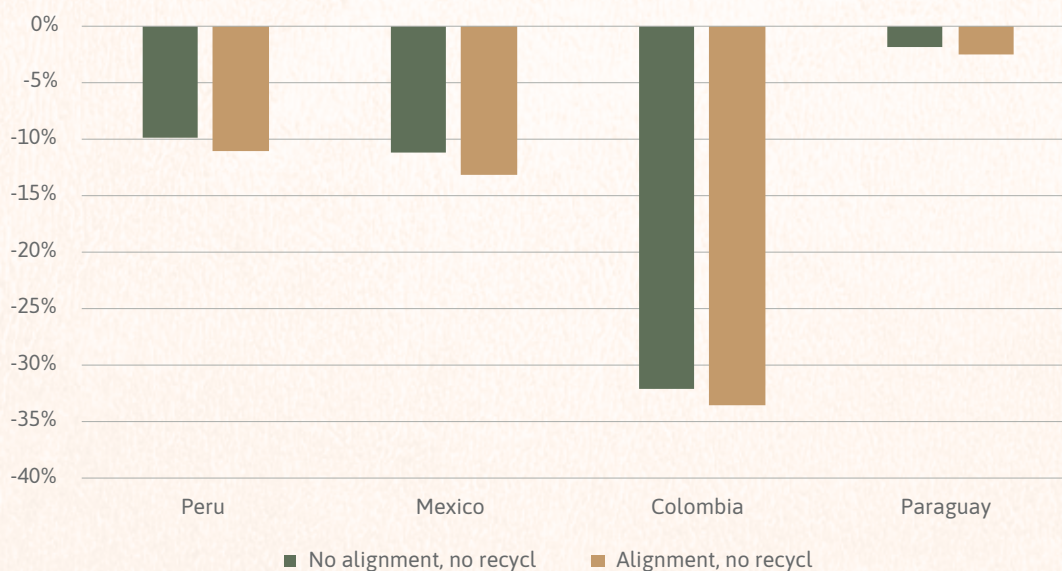


Source: Simulations based on total carbon price calculations using data of CPAT (Climate Policy Assessment Tool) (dashboard), International Monetary Fund and World Bank, Washington, DC, <https://www.imf.org/en/Topics/climate-change/CPAT>.

Estimates based on the Climate Policy Assessment Tool suggest that the impacts of the carbon price reforms on growth could be partially or fully offset when fiscal revenues are recycled (refer to figure 11). Revenue recycling is a critical element in determining the macroeconomic impacts of TCP reforms. As with any other tax reform, the macroeconomic impacts of TCP reforms depend on a complex combination of factors, including its effect on fiscal solvency, the ability of private agents to smooth their investment and consumption patterns, and so on. The simulations in this section provide an illustrative analysis and abstract on many of these factors. However, the results suggest that whether and how the additional fiscal revenues obtained are recycled is a key element in defining their overall macroeconomic impact, particularly on economic activity. In simulations carried out assuming the full recycling of revenues, 50 percent of which are used for public investment and 50 percent of which are used for transfers, the estimated negative impact on growth is close to -0.1 percent in Colombia and less than that in the other countries analyzed (refer to figure 11).

The analyzed carbon pricing reforms would significantly contribute to the reduction of energy-related emissions. Under the reform that aligns the TCP of all fuels to US\$60 per ton of CO₂ (without applying revenue recycling policies), energy-related emissions are estimated to decline by between 3 and 33 percent by 2030 depending on the country and relative to the baseline scenario (refer to figure 14). These reductions are significant, placing these countries closer to achieving Nationally Determined Contributions. The reform scenarios that imply an alignment of all fuel TCPs exhibit better emission reduction results compared with a reform scenario without alignment, while producing similar macroeconomic effects. This is because aligning all fuel TCPs to US\$60 per ton of CO₂ provides a consistent price signal for emissions, regardless of the energy source that generates the emissions. The scope for emissions reduction depends on the type of reform TCP implemented (for instance, with or without alignment), how well aligned the current fiscal system is with the emission content of each fuel, and how important the contribution of a given fuel on the country's emissions is and, thus, the potential for reducing the use and emissions of the fuel. For example, in Mexico, under the TCP alignment scenario, natural gas emissions (which represent 37 percent of all energy-related emissions) would decline more intensively because the TCP of natural gas would be increased from US\$1.0 to US\$60 per ton of CO₂, whereas the TCP would only increase to US\$30 per ton of CO₂ under the reform scenario without alignment (refer to annex figure D1). This result confirms that, for countries with biased energy mixes, ensuring that large sources of emissions are adequately taxed can have significant environmental effects.

Figure 14. Emissions reduction in 2030 under different TCP reforms, compared with the baseline scenario



Source: Simulations based on total carbon price calculations using data of CPAT (Climate Policy Assessment Tool) (dashboard), International Monetary Fund and World Bank, Washington, DC, <https://www.imf.org/en/Topics/climate-change/CPAT>. Note: The light blue bars show the scenario where all fuels' TCP are aligned, meaning that each fuels' TCP equals 60 USD by 2030. In contrast, the dark blue bars show the TCP scenario where the overall TCP increases to 60 USD, but the fuels' TCP differ (no alignment). In both scenarios revenues are not recycled.

TCP reforms have different impacts depending on how energy demand and investment respond to changes in energy prices and on the accompanying reforms targeted at the affected sectors. Energy prices influence energy decisions through several fundamental channels, including demand (in the short-term) and investment (over the medium term). Carbon pricing is an efficient policy instrument to reduce emissions and raise fiscal revenue to the extent that demand and investment react to consistently set price signals that are aligned with the externalities of emissions. In a system in which agents do not sufficiently react to changes in prices associated with regulations or misplaced incentives, variations in carbon prices will not result in corresponding changes in the use of energy or in the physical capital required to produce and use energy. In contrast, in systems with high flexibility, agents are more likely to react to moderate alterations in carbon prices and the expected future values. Still, it is unrealistic to expect that price signals alone will provide all the necessary incentives to drive the transformation of energy systems. A combination of sectoral reforms and stimulus, combined with a broader macroeconomic and regulatory framework that encourages competition and investment, is required to ensure that price signals are effective.

3.2. Roadmaps for policy reform and sectoral challenges

TCP reforms that increase the price of emissions and align the price across different energy sources face substantial technological and political challenges. Energy taxation in the LAC region is dominated by indirect carbon price instruments, which means that certain fuels have low or even negative TCPs, whereas others have high positive TCPs. This report finds that emissions from diesel, natural gas, and LPG tend to be underpriced across the region. This is the result of a combination of factors, including the influence of political cycles, the interaction of strong interest groups, the abundance of oil and gas resources, views about energy and its role in macroeconomic performance and sovereignty, and social considerations. Changing the taxation of these fuels can thus prove challenging, even if the potential benefits in additional fiscal revenue, reduction of CO₂ emissions, and acceleration of technological transformations are considered desirable by policymakers and large sections of society.

Combining sectoral policy reforms with energy tax changes should be the preferred strategy to achieve the best outcomes. Price incentives deriving from energy taxation and subsidies interact with regulations, contractual arrangements, and supply constraints, which also have a strong influence on energy-related decisions. Reforming these nonprice conditions, in parallel with energy taxes, can improve the effectiveness of price signals and support a smoother transition of the energy system and the economy. At the same time, given the political complexities, reforms that only alter taxes and subsidies may be considered opportunistic and face more resistance than reforms that are part of broader programs for the modernization of the energy sector. While an exhaustive analysis of the potential sectoral policies that could complement energy tax reforms is beyond the scope of this report, the following paragraphs describe several elements to consider in designing these policies and how they might interact with energy taxation.

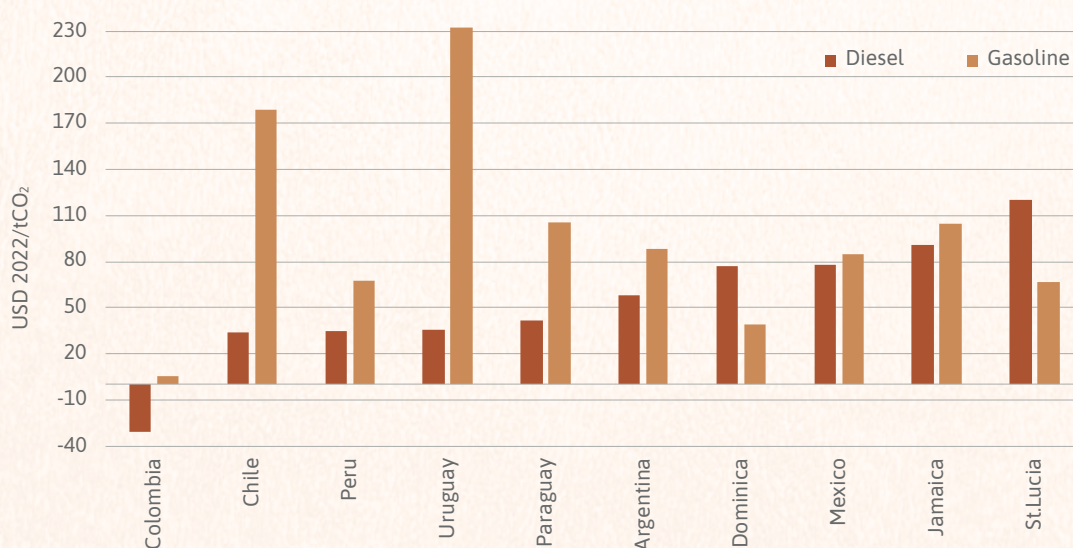
The transport sector and the role of diesel taxation

Concerns about transport sector strikes and inflation dynamics have historically led to low diesel taxes. Across the region, taxing diesel is politically difficult. Transport operators

have historically mobilized to oppose tax increases and demanded compensatory measures whenever diesel prices rise. Their ability to disrupt economic activity is a shared concern among policy makers in all countries. Policy makers are also wary of the inflationary impact of diesel tax increases because of the indirect effect of higher transportation costs on the cost of household consumption baskets. This has led to an equilibrium whereby the net taxation on diesel is much lower than the level suggested by environmental and health effects and below the level of taxation of gasoline (because gasoline is a final energy good mostly used by private vehicle owners). Several studies have established that the environmental externalities associated with diesel vehicles are more costly than those associated with gasoline engines: Harding (2014) confirms this for OECD countries, while Strand (2025) conducts a similar analysis on Brazil.

From a technological perspective, failing to tax emissions from diesel combustion adequately hinders the transformation of the transport sector (refer to figure 15). Relatively low (or even negative) carbon prices for diesel are not unique to the LAC region. However, this pricing structure may distort important use and investment decisions in the transport sector. Lower levels of diesel taxation incentivize the greater use of internal combustion trucks for passengers and freight, increasing the reliance on road transport over alternatives (such as rail transport). In heavy freight road transport, diesel is usually the most relevant energy option given the advantages of diesel engines in heavy-duty applications and the higher energy density of the fuel. Still, even in contexts where diesel is the preferred technological option, diesel taxation might affect the incentives of transport operators to adopt and invest in fuel efficiency, including upgrading old trucks to benefit from more efficient, modern engines. Research on a sample of 145 countries found a positive relationship between higher diesel prices and lower intensity of CO₂ emissions in the transport sector (Foster et al. 2021). Such higher prices might thus be a key instrument in decoupling transport emissions from GDP.

Figure 15. Average gasoline and diesel TCPs, by country, 2017–23



Sources: World Bank calculations based on data of WEB (World Energy Balances) (dashboard), International Energy Agency, Paris, <https://www.iea.org/data-and-statistics/data-product/world-energy-balances>; WEO (World Economic Outlook Databases) (dashboard), International Monetary Fund, Washington, DC, <https://www.imf.org/en/Publications/SPROLLS/world-economic-outlook-databases#sort=%40imfdate%20descending>. Values are expressed in 2022 US dollars per ton of CO₂.

The taxation of gasoline and diesel is particularly relevant in decisions affecting urban buses. Bianchi Alves, Bou Mjahed, and Moody (2023, 38) consider that the “reform of fuel subsidies or taxes is another critical way to ‘level the playing field’ between more space- and energy-efficient modes and single-occupancy/under-loaded vehicles. They thus emphasize the importance of ensuring that subsidies for private vehicles are removed so that buses and other large occupancy options (which have a much lower carbon footprint than private vehicles) do not face undue barriers in use. Options for the adoption of electric buses are increasing (Briceño-Garmendia, Qiao, and Foster 2023). A recent study on large cities in Argentina, Brazil, Chile, Mexico, and Uruguay found that, with the price of diesel artificially lower, the financial accounting of vehicle operations tends to favor conventional vehicles (World Bank 2019, 37).

Complementary changes in regulations and market structures in the transportation sector are necessary to facilitate the action of pricing signals. For example, in urban city transportation, the design of route concessions is particularly relevant. The frequency of concessions renewals can mean that existing buses are locked in and cannot be replaced even if carbon price signals are improved. This was found to be the case in several LAC cities, which automatically extended existing concessions at expiry (World Bank 2019). In addition, the design of concessions frequently biases operators toward low fuel economy diesel buses because it does not factor in the local pollution costs of diesel engines in the concession criteria. Cities can collect data on local externalities to raise awareness on these issues (Briceño-Garmendia, Qiao, and Foster 2023). Limitations in credit availability can also bias operators towards low efficiency vehicles, as they require lower upfront investment to be financed. Reforms aimed at improving competition in the freight transport sector are also important. If freight markets function with a limited number of operators and with stable market quotas, the probability of adoption of lower-carbon technologies is reduced because incumbents defend the current equilibrium.

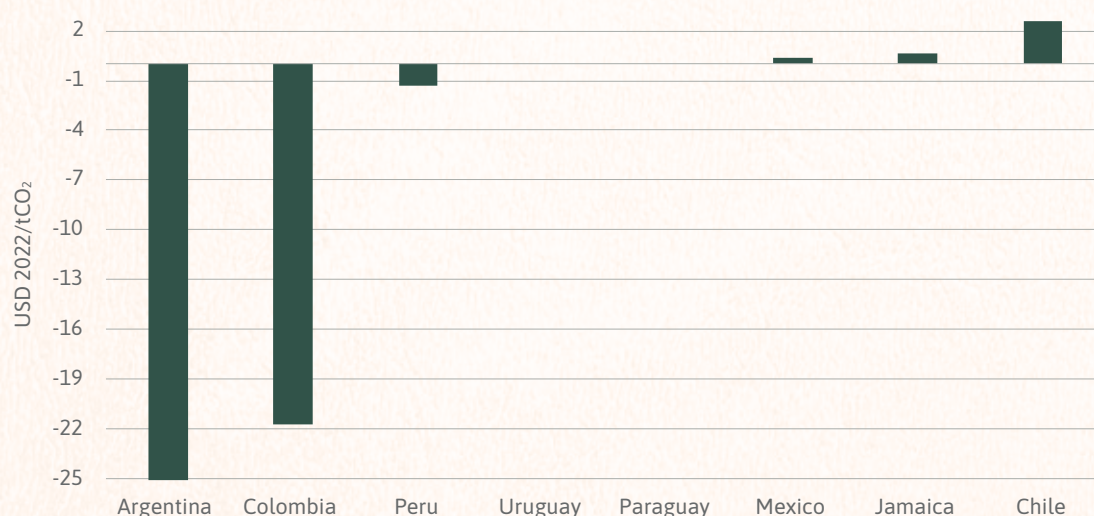
While there is no easy solution to the political economy of diesel tax reforms, some avenues may help, such as policy incentives for investment in efficient transport equipment. One potential strategy is to shift policy away from the artificially low prices of diesel toward incentives for investment in efficient transport equipment. For instance, tax incentives, such as accelerated amortization schedules, or direct subsidies for more efficient transport equipment could take the place of diesel consumption subsidies. If carried out gradually, this strategy would create an opportunity for transport operators to renew their fleets and capitalize immediately on the benefits they would have received through diesel subsidies over several years. Another important dimension is the communication and gradual implementation associated with reforms. Recent studies confirm that anticipation and coordination with trade associations in the transport sector can help avoid costly distortions because of strikes (Moerenhout et al. 2024).

Electricity sector and the role of natural gas taxation

Low or negative TCPs for natural gas have led to greater dependence on this fuel, which creates risks for the region (refer to figure 16). Over the past 40 years, natural gas has been the most rapidly growing fuel in the region’s primary energy supply, a trend that continued into the last decade. As a result, the related imports have doubled in the last decade because the

region is a net importer of natural gas, while exports from producing countries have declined in an effort to address domestic demand. Natural gas consumption is particularly high in the largest LAC economies. Mexico uses more natural gas than Germany; Argentina uses more than France; and Brazil uses approximately the same amount as Spain (IEA 2024a, 2024b). The LAC region holds large reserves of natural gas, accounting for approximately 15 percent of global resources. However, several of the countries that have large resources of natural gas are not connected to the countries with higher demand in the region. At the same time, the region is unlikely to become a major global natural gas exporter because of the distance from key international markets and the high costs and complexity associated with the liquefaction and transport of natural gas (Fay et al. 2017). Tapping into the region's natural gas resources would require substantial investment because LAC's production capacity, pipeline infrastructure, and regasification capacity are underdeveloped (Fay et al. 2017). In addition, recent geopolitical events and supply disruptions have resulted in high volatility in global natural gas markets. As a result of these turbulences, combined with a growing emphasis on decarbonization and renewables, the role of natural gas in ensuring energy security is increasingly questioned.

Figure 16. Average natural gas TCP, by country, 2017–2023



Sources: World Bank calculations based on data of WEB (World Energy Balances) (dashboard), International Energy Agency, Paris, <https://www.iea.org/data-and-statistics/data-product/world-energy-balances>; WEO (World Economic Outlook Databases) (dashboard), International Monetary Fund, Washington, DC, <https://www.imf.org/en/Publications/SPROLLS/world-economic-outlook-databases#sort=%40imfdate%20descending>.
Note: Values are missing for Dominica and St. Lucia.

Failure to price natural gas emissions properly undermines the financial viability of renewable electricity generation and industrial electrification. Renewable technologies are already cost-competitive in most markets, presenting an opportunity to achieve lower energy costs and decarbonize the economy. However, current taxes and subsidies for natural gas could lock LAC countries into a path that prevents the technological adoption of renewables. Global natural gas consumption is projected to decline in the coming decades as decarbonization trends advance. Scenarios of the International Energy Agency (IEA) that align with Nationally Determined Contributions indicate that natural gas use in LAC would

begin to decline gradually before 2030, with this downward trend accelerating thereafter. Achieving net-zero goals also requires a more rapid reduction in natural gas use (IEA 2023b). In both cases, the reduction in natural gas would need to be accompanied by the growing adoption of renewable sources in the power generation sector, mainly solar photovoltaics and wind. In this context, failure to tax the emissions of natural gas properly, plus regulatory environments that do not facilitate the entry of renewable players and investment, could mean that LAC countries would be left out of this critical technological transformation. Also, although industrial processes based on electricity are progressing more slowly (IEA 2024a, 2024b), they are likely to accelerate in coming years.

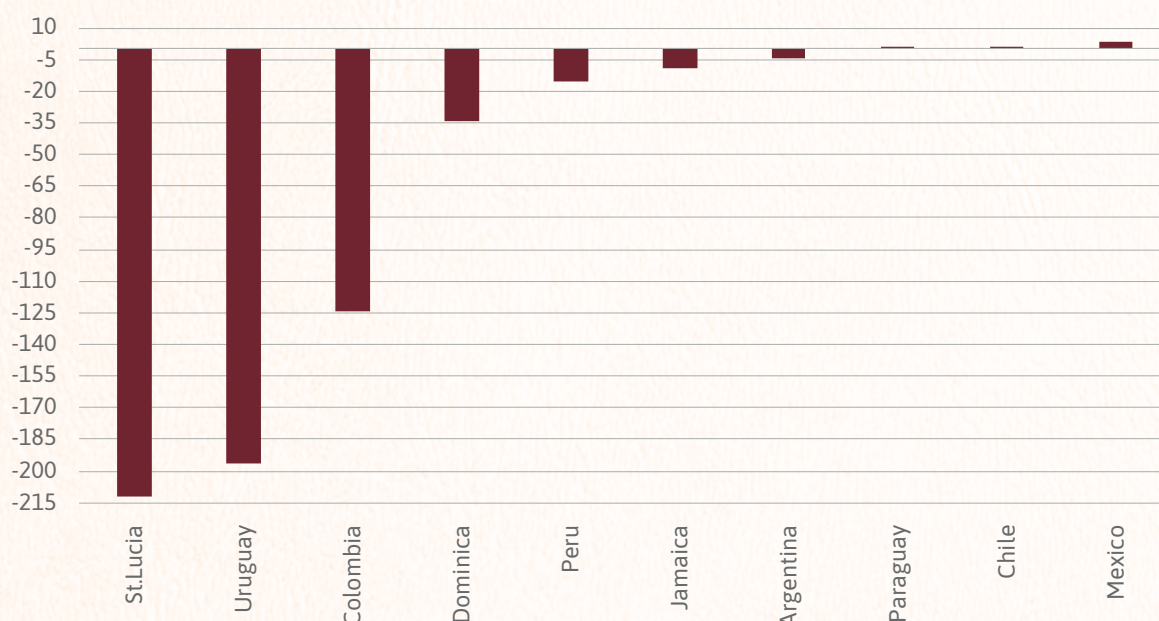
Improving carbon price signals can influence electricity generation and demand decisions, which can have significant effects on emissions and technology, but only if complementary reforms ensure that electricity prices and capacity decisions reflect the true costs.

Changes in energy taxation that increase the costs of the emissions of fossil fuels alter both the short-term and the medium-term equilibrium in electricity markets, but the direction and pace of these changes will depend critically on several aspects of electricity market structure and design (World Bank 2024a). For instance, in markets where dispatch is not guided by marginal cost merit order, the higher costs of fossil fuel operators because of the removal of natural gas subsidies will not translate into lower shares for these generators, nor will they allow renewable plants to gain market share with more competitive bids. Over the medium term, the increase in electricity prices associated with the increase in carbon prices would entice the entry of competitor technologies with lower emissions, particularly renewables, but regulations that allow entry are necessary. Finally, a wide variety of policies are typically applied in the power sectors (renewable portfolio requirements, resource adequacy constraints, and so on), and many of these can potentially interact with the TCP of fuels used in the generation of electricity. All these considerations must be taken into account in deciding on the TCP policies to be implemented in the electricity sector (World Bank 2024a).

Clean cooking and the role of liquefied petroleum gas subsidies

LPG has historically been promoted in the region to encourage households to transition away from highly polluting solid fuels, such as coal and firewood (refer to figure 17). The use of solid fuels for cooking has severe negative health consequences, including responsibility for an estimated 3.2 million deaths in 2020 (WHO 2024). This practice is more prevalent in low-income and rural households than in wealthier and urban ones, and it disproportionately affects young children and women, who are often responsible for cooking. As a result, important health benefits are linked to transitioning to cleaner sources of energy for cooking, which, in most cases, outweigh the benefits of reducing CO₂ emissions and the associated externalities. The promotion of bottled LPG has been the main strategy to encourage this transition both in LAC and in other regions (Kojima 2021). LPG subsidies have played a key role in this. Direct financial incentives to encourage households to adopt LPG equipment (such as stoves) and use the fuel have been offered in many countries across the region and has proven effective in reducing the reliance on solid fuels. Over the past decade, the share of LAC households using solid fuels has decreased by 5 percentage points, reaching 16 percent in 2020 (HEI 2024). Other factors, such as urbanization, rising income levels, changes in household composition, and access to information, have also been found to influence the adoption of cleaner cooking technologies (Ravillard et al. 2023).

Figure 17. Average LPG TCP, by country, 2017–2023



Sources: World Bank calculations based on data of WEB (World Energy Balances) (dashboard), International Energy Agency, Paris, <https://www.iea.org/data-and-statistics/data-product/world-energy-balances>; WEO (World Economic Outlook Databases) (dashboard), International Monetary Fund, Washington, DC, <https://www.imf.org/en/Publications/SPROLLS/world-economic-outlook-databases#sort=%40imfdate%20descending>.

The design of fiscal instruments to promote clean cooking requires careful consideration of fiscal efficiency, distributional impacts, administrative capacity, and available technological options. Administrative and technological limitations mean that some LPG subsidies are likely to remain necessary to promote cleaner cooking among poor rural households. However, generalized price subsidies, such as those implemented in Dominica or Uruguay, are relatively costly and inefficient because they benefit segments of the population that do not necessarily need help. It is important to improve the targeting of these subsidies, to make them more efficient and ensure that households face appropriate incentives. It is also important to widen the technological choices available for the modernization of cooking. The inclusion of electric cooking alternatives as part of the range of equipment supported by these policies, jointly with programs to improve electricity access and affordability, are an attractive option from a financial and environmental perspective.

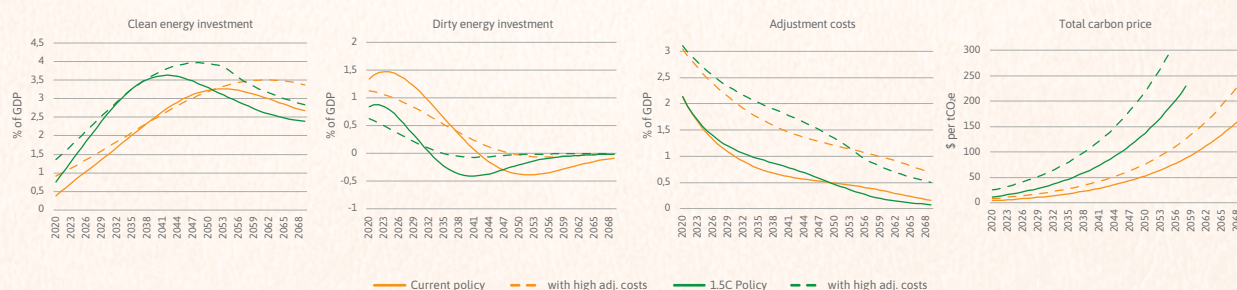
Enabling the macroeconomic and institutional environments

Beyond sectoral policies to support the transformation of energy systems, creating favorable macroeconomic conditions for investment and technology adoption is crucial to ensuring the efficient outcome of carbon price reforms. In the LAC region, two challenges stand out: high capital costs for new investment projects and the lack of strong innovation and competition dynamics. High interest rates and the cost of capital pose significant barriers

to the adoption of green technologies. Data of the IEA Cost of Capital Observatory (IEA 2023a) show that the cost of capital (nominal, after taxes) for a typical solar photovoltaics plant in Brazil was the highest among a wide set of emerging economies, ranging between 12.5 percent and 13.5 percent in 2021. In the case of Mexico, the same investment had a capital cost of between 9.5 percent and 10.0 percent, comparable with the range observed in India. The cost of capital was two to three times higher in Brazil and Mexico than in China, Europe, and the United States (IEA 2023a). These findings extend to other technologies beyond electricity generation, as a common characteristic of most low-emission technologies is the higher capital expenditure costs. Despite the lower operating costs because of the greater efficiency, a diesel truck meeting Euro 5 emission standards is more expensive and thus requires more financing than a less-efficient, more polluting older truck. Lack of competition and dynamic technological adoption is a long-standing issue in the region, and its consequences are particularly acute in times of fast technological transformation as the one experienced currently in the energy sector.

Removing barriers to investment and increasing the availability of alternative technologies boosts the effectiveness of a given level of TCP. The appropriate level of the nationwide TCP (and the corresponding level for each fuel) depends strongly on the flexibility of investment and the cost differential between high- and low-carbon technologies. Results from the general equilibrium model described in Göth and Zessner-Spitzenberg (2024) illustrate this point. If large costs are involved in adjusting the capital stock in an economy, a much higher carbon price is required to achieve the same reduction in emissions, and this reduction depends more heavily on reducing energy use and less on the transformation of energy supply (refer to figure 18). Similar dynamics are observed if low-carbon technologies face large cost disadvantages relative to other energy technologies (refer to figure 19). Some of these cost differentials reflect genuine higher costs associated with these technologies, but others, such as those linked to high financial costs or poor technology adoption environments, do not. Overall, achieving a target level of emissions reductions will require more moderate carbon prices in economies in which the enabling environment for investment and technology adoption has been established.

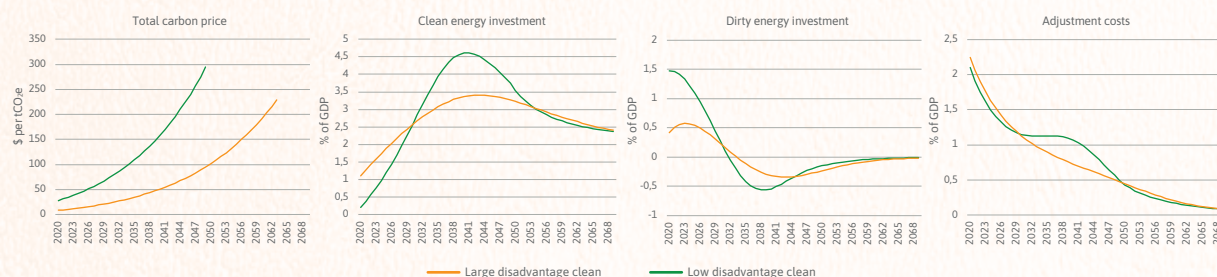
Figure 18. The estimated impact of high adjustment costs on the transition path



Sources: World Bank calculations based on Burda, Göth, and Zessner-Spitzenberg 2025; Göth and Zessner-Spitzenberg 2025; Göth, Zessner-Spitzenberg, and Fischer 2025.

Note: Adjustment costs as a share of GDP are defined as the sum of the sector-specific convex costs of capital adjustment on net investment in the clean and dirty energy sector and the nonenergy sector at each point in time over model units of output at each point in time. For more details on the model, refer to annex B.

Figure 19. The estimated impact of differences in the productivity of clean and dirty energy technology on the transition path



Sources: World Bank calculations based on Burda, Göth, and Zessner-Spitzenberg 2025; Göth and Zessner-Spitzenberg 2025; Göth, Zessner-Spitzenberg, and Fischer 2025.

Note: Adjustment costs as a share of GDP are defined as the sum of the sector-specific convex costs of capital adjustment on net investment in the clean and dirty energy sector and the nonenergy sector at each point in time over model units of output at each point in time. For more details on the model, refer to annex B..

4

THE WELFARE AND DISTRIBUTIONAL IMPLICATIONS OF TOTAL CARBON PRICE REFORMS



Understanding the welfare and distributional impacts is crucial to the successful implementation of the TCP reforms. The potential environmental and fiscal benefits of carbon pricing reforms described above must be weighed against the equity implications. Carbon pricing affects households both as consumers (users of income) and income generators (sources of income) (Fullerton 2011; Goulder et al. 2019; Rausch, Metcalf, and Reilly 2011). The design of fiscal-energy policies must reflect these welfare and distributional effects, in both in the short and long term, to insure their successful implementation (Hill, Nguyen, and Doan 2024).

Through its impact on energy use, productivity, and investment, carbon pricing is expected to contribute to the structural transformation of the economy, resulting in potentially significant impacts on household income generation activities (the sources of income). Carbon pricing is expected to reduce the demand for high-emission products, while growing the demand for low-emission products, thereby affecting the structure of the economy, with implications for employment and livelihoods (Borissov, Vinogradova, and Bretschger 2019; Carbone et al. 2020). The welfare and distributive impacts of this transition depend on which sectors are affected the most, who works in these sectors and the quality of their jobs, the degree of skills transferability, and the capital intensity of new technologies. The literature shows that workers in contracting sectors have a different profile than workers in expanding sectors (Hanson 2023; Winkler et al. 2024; World Bank 2022a).⁵ Furthermore, the growth of low-emissions sectors may alter the relative returns on production factors, such as land, labor, and capital, the impact of which on household income would depend on how these assets are distributed among the population.⁶

In the short term, carbon pricing reforms result in increases in the price of energy, negatively affecting household purchasing power (the uses of income) both directly and indirectly. The impact depends on several factors: (1) the reliance of households on fuels as energy sources (direct price effect); (2) the size of the fiscal-induced fuel price shock; (3) the intensity of fuel use by the productive sector, whose goods and services are consumed by households (indirect price effect); and (4) accompanying revenue recycling measures adopted by the government. The combined effect of these factors is analyzed in this section.

Over the medium term, however, household price elasticity of demand for energy-intensive goods and services becomes more important. Higher energy prices will incentivize consumers to reduce their spending on energy-intensive items. However, their response will depend on multiple factors, such as their income level, preferences, the availability and affordability of substitutes, and perceptions regarding the duration of the price shock.⁷ For instance, energy substitution might prove challenging and will likely be uneven across households because

5 This illustrates the need for policy packages to support individuals at risk of job losses and job displacement, which could include compensatory transfers and insurance programs, and to support active labor market policies, such as reskilling, upskilling, job-searching, and matching programs (Hill, Nguyen, and Doan 2024).

6 For example, Beck et al. (2015) show that the introduction of a carbon tax in Canada causes real wages to decline because higher energy prices induce mobile capital to move out of energy-intensive sectors. In contrast, labor is less mobile and, so, bears the burden of the tax. Conversely, Mayer et al. (2021) find that decarbonization policies in Austria decrease the returns on capital relative to that on labor.

7 The transition of households away from high emission energy sources relies on the accessibility, affordability, and reliability of alternatives, such as green electricity, public transport, and electric vehicles (Acharya and Marhold 2019).

cleaner technologies, such as solar photovoltaics or electric vehicles, tend to have high up-front costs, making the switch expensive (Wang et al. 2016, 2019).⁸ Another important factor is the perceived duration of the price shock. If households perceive the shock as temporary, they may be less inclined to adjust their consumption patterns than they would be had they viewed the change as permanent. Empirical evidence on the size of these substitution effects and the related dynamics is insufficient in the LAC region.

The welfare impacts of carbon pricing are expected to be greater in countries in which households spend a larger portion of their income on fuels, such as Argentina, the Dominican Republic, Mexico, and Panama.⁹ Households in the region spend an average of close to 4 percent of their incomes on fuels, with substantial heterogeneity across countries (refer to annex C, figure C1).¹⁰ The share is comparatively high in Argentina (6.1 percent), Mexico (5.3 percent), and Panama (6.7 percent), but quite low in Bolivia (1.4 percent), Ecuador (1.5 percent), and Peru (1.7 percent). However, fuel expenditures may not completely reflect the household intensity of fuel use because they capture differences in the prices paid, in addition to the quantities purchased. A low share of household income dedicated to fuel expenses may merely reflect heavily subsidized fuel prices or the existence of informal fuel markets that evade taxes.¹¹ In fact, informal fuel purchases are nontrivial in several countries, representing, for example, 15, 27, and 11 percent of total household LPG spending in Argentina, Colombia, and Mexico, respectively (refer to annex C, figure C2).

Transport fuels, especially gasoline, are important components of total household fuel expenditure, and, thus, taxation of the emissions could affect purchasing power comparatively more. In all countries, except El Salvador and Peru, the fuel with the highest income share is gasoline, accounting for an average of 2.4 percent of household income (refer to annex C, figure C1). As a share of household income, expenditure on other transport fuels, such as diesel and ethanol, is relatively small. For cooking and heating fuels, households spend an average of 0.7 percent of their incomes on LPG. Natural gas is a less common energy source for households in the region, except in Argentina, Colombia, and the Dominican Republic. The income shares of other fuels, such as kerosene and fuel oil, are negligible in most countries.

Within countries, fuel spending patterns vary considerably depending on household position in the income distribution. In absolute terms, expenditure on fuels in LAC countries is higher among the middle class and wealthier segments of the population (refer to figure

8 For an effective implementation of climate mitigation policies, it is crucial for the government to have policies in place to support the shift toward renewable energy sources, including investments in infrastructure that enable households to adopt sustainable behaviors.

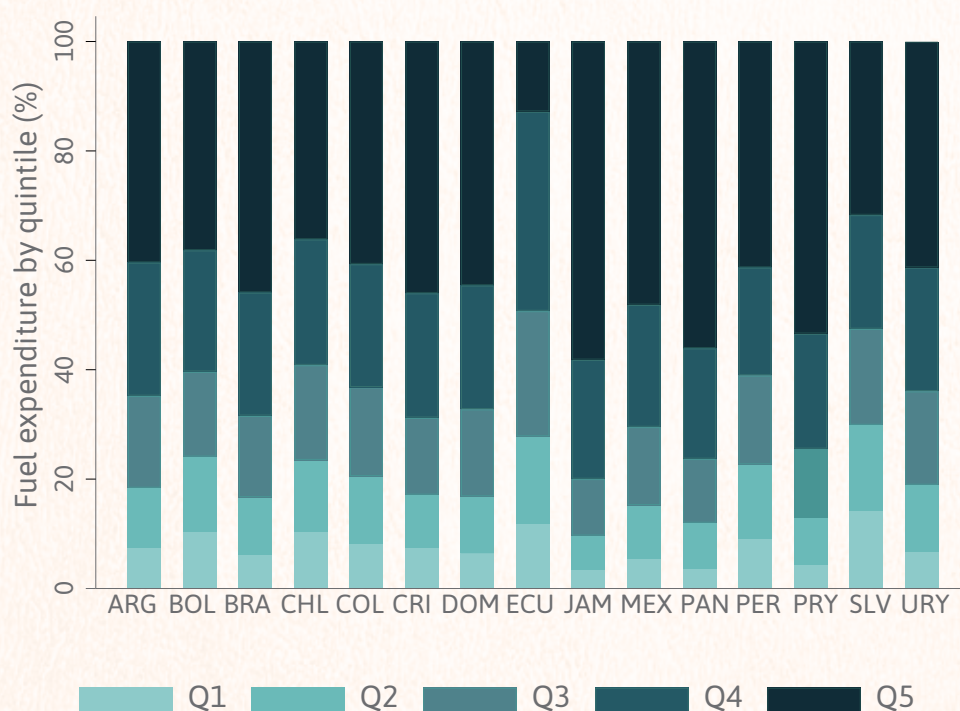
9 The cross-country heterogeneities analyzed throughout this section might be partly driven by differences in the data (for example, year of the household survey, definition of income, data collection method, type of fuels covered by the survey). Refer to annex C, table C1 for a detailed list.

10 The statistics cited in this chapter refer to the subset of 15 countries on which detailed household expenditure data could be obtained (refer to annex C, table C1). These countries accounted for 85.7 percent of the LAC population in 2022.

11 For instance, fuel subsidies represent 2.7 percent and 3.7 percent of GDP in Bolivia and Ecuador, respectively, compared with the LAC regional average of 0.6 percent, which results in artificially low fuel prices. Refer to 2023 data of Climate Change: Fossil Fuel Subsidies (dashboard), International Monetary Fund, Washington, DC, <https://www.imf.org/en/Topics/climate-change/energy%20subsidies#:~:text=Explicit%20subsidies%20occur%20when%20the,as%20distribution%20costs%20and%20margins.>

20). The richest 60 percent of households in the income distribution account for 81 percent of total fuel expenditure, on average, across the countries analyzed, compared with 19 percent among households in the bottom 40 percent. However, fuel expenditure represents a higher share of the income of poor and vulnerable households (refer to figure 21). This pattern is more pronounced in Brazil, Chile, and Colombia, where fuel expenditure for households in the bottom 40 and the top 60 is, respectively, 6.9 percent of income versus 4.2 percent, 7.0 percent versus 4.1 percent, and 5.1 percent versus 2.2 percent.¹² The relative importance of fuels also differs across households. On average, the income share of LPG is 2.4 times larger among households in the bottom 40 than among households in the top 60. There is no such gap in the case of gasoline.

Figure 20. Distribution of total household fuel expenditure across income quintiles, by country

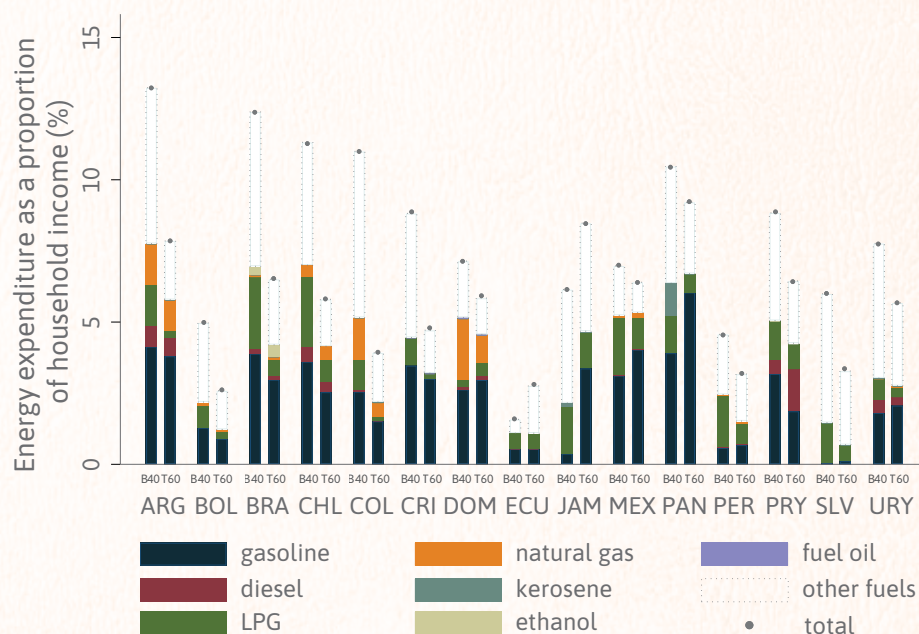


Source: Authors' calculations based on nationally representative household expenditure surveys. For more details, refer to annex C, table C1.

Note: For each country, total household fuel expenditures include expenditures in gasoline, LPG, diesel, natural gas, kerosene, ethanol, and fuel oil. Individuals are ranked based on their per capita disposable income and grouped by income quintiles (Q1 to Q5).

12 The opposite is true in Jamaica and Panama, where fuel expenditure accounts for a larger share of the incomes of wealthier households.

Figure 21. Energy expenditure relative to household income, by income group and country



Source: Authors' calculations based on nationally representative household expenditure surveys. For more details, refer to annex C, table C1.

Note: In El Salvador, gasoline expenditure is only reported for work-related activities. The category "other fuels" includes the fuels not listed in the legend of the figure, which in most cases refers to electricity. Statistics are presented separately for households classified in the bottom 40 percent of the per capita income distribution (B40) and those in the top 60 percent (T60).

For some households, fuel spending can represent a considerable financial burden. The statistics cited above are based on averages across households. However, not all households purchase fuel, and, among those that do, they do not necessarily buy every type of fuel.¹³ As a result, the shares of fuel expenditure relative to income rise substantially if one focuses on the subset of households that report positive fuel expenditures (refer to annex C, figure C3). For instance, among the 20 percent of households in Colombia in the bottom 40 that report positive spending on gasoline, this expenditure represents 10.6 percent of their incomes (compared with 2.5 percent if one considers the average across all Colombian households in the bottom 40). This underscores the importance of identifying the most highly affected households and their characteristics in conceptualizing targeted compensation measures to offset the impacts of carbon pricing reforms or in designing programs to encourage the adoption and use of cleaner energy alternatives.

Higher fuel prices can also affect the purchasing power of households by increasing the cost of nonenergy goods and services the production or transportation of which depend on the fuels. These indirect price effects are expected to be larger in countries in which productive structures rely heavily on fuels or in which goods and services are fuel-intensive, such as food products and passenger transport services.¹⁴ In the LAC region, food spending represents an average of 19.1

13 Households in the region are more likely to purchase LPG than any other fuel type, except in Colombia and the Dominican Republic, where households tend to use natural gas instead of LPG for cooking and heating. On average, 56.2 percent of households report positive expenditures on LPG, compared with 33 percent on gasoline.

14 For instance, in agriculture, diesel is used for a wide range of tasks, including irrigation, seeding, fertilization, and harvesting, constituting a significant component of the cost structure.

percent of household income. Consequently, carbon pricing reforms could have considerably large indirect effects on household purchasing power (refer to annex C, figure C4). This is particularly true of households in the bottom 40, which spend 2.3 times more on food items relative to the top 60.¹⁵ Similarly, households allocate an average of 3.9 percent of their incomes to transport services. Thus, it may be that the indirect impacts outweigh the direct impacts, especially in the case of diesel and fuel oil, which are widely used by the productive sector.

The factors outlined here interact with one another and collectively determine the overall impact of carbon pricing reforms on household welfare in the short term. The analysis that follows uses a bottom-up approach that relies on detailed household survey income and expenditure data to consider these factors together to assess the short-term welfare and distributive effects of selected carbon pricing policy scenarios. This represents a partial equilibrium exercise that focuses on the likely impacts of carbon pricing on monetary indicators of welfare, leaving aside other nonmonetary welfare dimensions, such as the potential health impacts arising from air pollution.

4.1. Which fuel TCP reforms matter most and to whom?

The Commitment to Equity methodology provides a widely recognized framework for assessing the short-term distributional impacts of fiscal reforms, including TCP. The methodology consists of allocating taxes (direct and indirect), contributions, government transfers, subsidies, and public spending to households, allowing for a comparison between household per capita income before fiscal interventions (prefiscal income) and after such interventions (postfiscal income) (Lustig 2022a, 2022b).¹⁶ The analysis presented in this section expands on the existing fiscal microsimulation tools for Brazil, Jamaica, Mexico, Paraguay, Peru, and Uruguay to model the direct and indirect price effects of TCP reforms on household per capita income by type of fuel: gasoline, diesel, LPG, natural gas, kerosene, and ethanol.¹⁷

The methodology focuses on the impact of carbon pricing reforms on the consumable income per capita of households. Following the Commitment to Equity approach, the analysis focuses on estimating changes in consumable income per capita—because this is the income concept immediately affected by carbon pricing policy—across several policy reform scenarios at a baseline year. Under this methodology, carbon pricing policies are the only factor affecting retail fuel prices, while other factors are assumed to remain constant across scenarios (for instance, profit margins, refining costs, international oil prices). For the estimation of the indirect price effects, the cost-push model is applied using the latest national input-output tables available (Inchauste, Goraus, and Carrasco 2022).

15 Food spending is particularly important among poorer households in Bolivia, Panama, Paraguay, and Peru.

16 The microeconomics literature proposes several methods to measure welfare losses derived from price changes, such as consumer surplus variation, compensating variation, equivalent variation, Laspeyres variation, and Paasche variation (Araar and Verme, 2016). The methodology used in this report follows a Laspeyres index, that is, welfare losses refer to the exact change in income necessary to purchase, after the price variation, the same bundle of goods purchased before the price variation. This method only requires knowledge of initial quantities and changes in prices and, thus, is particularly useful if there is lack of information on utility, the demand system, and elasticities. See, for example, Labandiera, Labeaga, and Rodríguez (2009), Renner, Lay, and Greve (2018), and Tovar-Reaños, Angel, and Lynch (2019) for alternative methodological approaches to measuring the household welfare impacts of energy policy.

17 See annex C, table C2 for the list of fiscal interventions included in each country's fiscal microsimulation tool. Electricity taxes and subsidies are outside the scope of this study because they do not typically differentiate based on energy sources (high vs. low emissions), and their estimation would require comprehensive cost and price information, which is not readily available for most countries.

Despite the relevance of the analysis in informing the design of carbon pricing policy, it is important to highlight some of the limitations. First, while efforts have been undertaken to harmonize approaches across countries, differences in estimated impacts could still be driven by factors such as the year of the baseline model, underlying household survey data, and other interventions included in the model. Second, the analysis is a partial equilibrium exercise and, thus, does not account for the behavioral response of households to tax-induced fuel price changes—mainly because of the lack of estimates of cross-price elasticities across countries and the income distribution—or general equilibrium and long-term effects (such as changes in employment). Third, it does not adequately represent certain population groups, particularly the wealthiest households and hard-to-reach individuals. Fourth, the methodology exclusively focuses on households as the unit of analysis, overlooking firms.

To achieve a closer understanding of the fuel-specific welfare and distributional impacts of TCP reforms, an illustrative exercise first models a uniform tax-induced price increase in all fuels. Comprehensive carbon pricing reforms can affect fuel prices in different ways. In addition, household spending patterns vary across fuel types. As a result, a price shock of the same magnitude can have different distributional and welfare implications across fuel types. To understand the overall effects of carbon pricing reforms, a hypothetical increase in taxes on fuel emissions is simulated. In this illustrative scenario, the increase in taxes results in an immediate homogeneous 25 percent rise in the price of each fuel.¹⁸ Next, the effects of four standardized reforms increasing and aligning carbon prices are assessed.

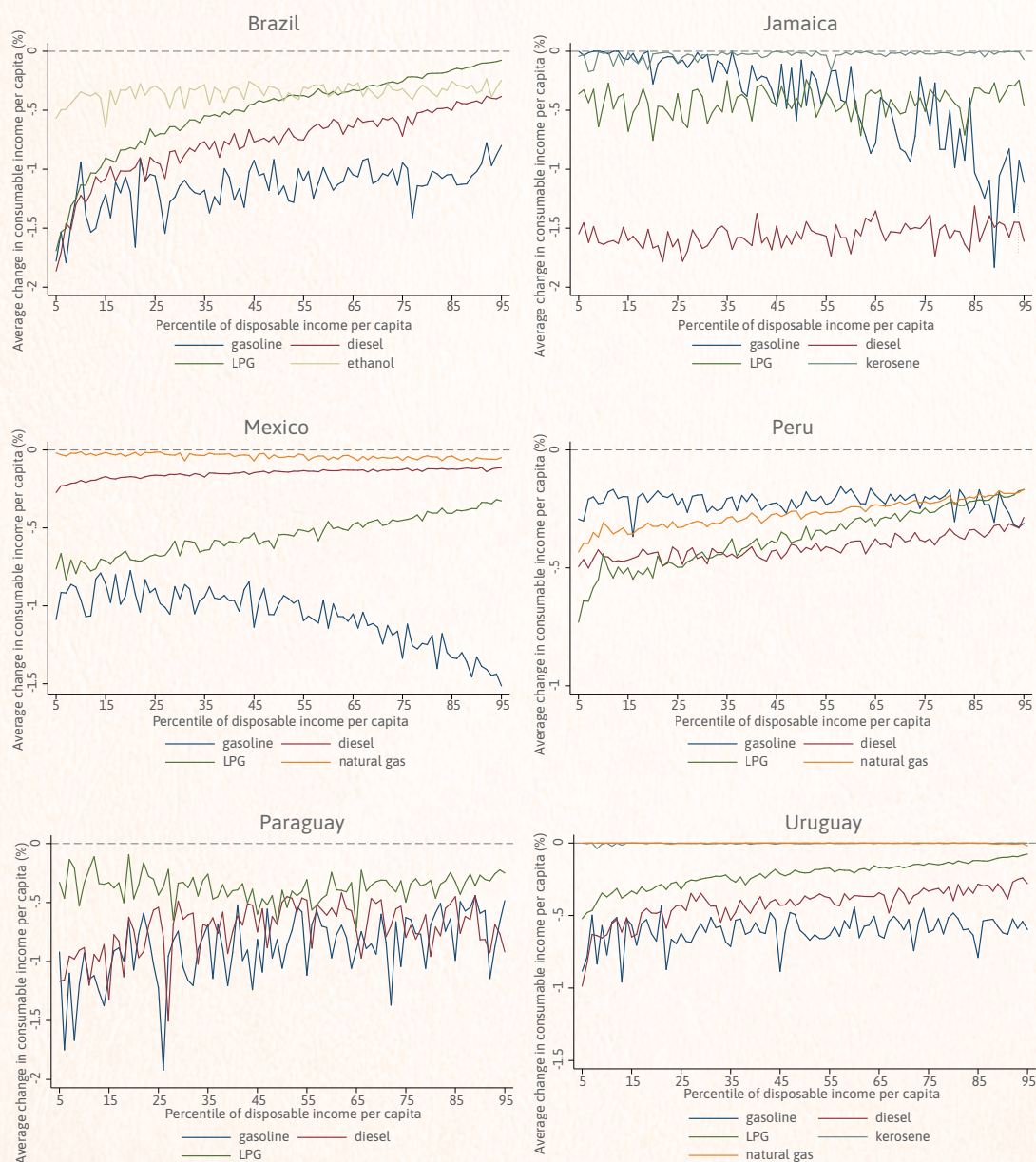
A tax-induced increase of 25 percent in fuel prices negatively impacts household income in the short term. A simultaneous 25 percent increase in all fuel retail prices, associated with higher taxes on emissions, is estimated to lead to a reduction in household per capita income by 2 percent on average in the LAC countries analyzed (refer to annex C, figure C5). This is equivalent to about half the impact of the average annual inflation on income in these countries over 2014–19. A comparison across countries reveals that average per capita income declines by 2.8 percent in Brazil, while it decreases by 1.3 percent in Peru and Uruguay.

Among fuels, taxes on gasoline emissions have the largest impact on household income because of the higher household spending shares on gasoline (except in Jamaica and Peru), followed by diesel and LPG (refer to figure 22). For example, in Brazil, a 25 percent price rise in gasoline leads to an average per capita income loss of 1.2 percent (representing close to 40.0 percent of the total 2.8 percent loss mentioned above). Although diesel is not directly used by most households, taxes on diesel emissions have a general inflationary effect by increasing the production and distribution costs of a wide range of goods and services. This indirect price effect can be as large as or even larger than the impact of carbon pricing on other fuels extensively purchased by households, such as LPG. The indirect effects of diesel are particularly large in Brazil, Jamaica, and Paraguay, suggesting that the economic structures in those countries are more dependent on this fuel compared with other countries.¹⁹

18 For reference, the simulated fuel price shock is smaller than the increase in international oil prices that occurred in 2021–22 (EIA, 2023).

19 Differences in indirect effects across countries may arise, in part, because of the reference year of the input-output table used and the assumptions made to map fuels to sectors. In the case of Jamaica, diesel and fuel oil are mostly used by the bauxite mining and alumina refining, electricity and water supply, and transport services sectors. In Brazil, indirect effects are primarily driven by the transport, commerce, and agriculture sectors.

Figure 22. Short-term income effects of a 25 percent fuel price increase because of higher taxes on fuel emissions



Source: World Bank calculations based on country-specific microsimulations.

Note: The figure shows the estimated percentage change in household per capita consumable income between the baseline and the 25 percent price increase scenarios for each country and fuel type. The results are presented as the average across households in each percentile of the per capita disposable income distribution. Individuals in the bottom and top 5 percent of the disposable income distribution are excluded because of the large variations in the data. For more details, refer to annex C, table C2.

Taxes on fuel emissions are largely paid by the middle class and wealthier segments of the population, but their impacts disproportionately fall on less well off households, particularly in the case of LPG taxes. Households in the top income quintile are estimated to contribute between 40 percent and 50 percent of the additional tax revenue because they spend more on fuel-intensive goods, compared with a contribution of 6 percent to 9 percent among households

in the bottom quintile (refer to annex C, table C3). Still, taxes on fuel emissions account for a larger share of the income of the poor and vulnerable. This is particularly true of LPG because of the greater reliance on this energy source for cooking among lower-income households (except in Jamaica and Paraguay). On the other hand, the burden of gasoline taxes is similar across the distribution, or even larger among higher-income households, such as in Jamaica and Mexico.²⁰ For instance, a 25 percent rise in LPG prices (because of higher taxes on the related emissions) would result in an average per capita income loss of 0.6 percent among individuals in the first quintile in Peru, compared with 0.2 percent among individuals in the fifth quintile. In gasoline taxes, the average decline in per capita income in Peru is estimated at 0.2 percent and 0.3 percent among individuals in the bottom and the top quintile, respectively. Along these lines, the Kakwani progressivity index is negative and the largest for LPG taxes, whereas it is positive (Jamaica and Mexico) or near-zero (Uruguay) for taxes on gasoline emissions (refer to annex C, table C4).²¹ This helps to explain why most Latin American countries tax gasoline emissions at a higher rate than the taxes on LPG, which is also consistent with equity objectives.

Overall, the analyzed increase in carbon pricing is estimated to lead, in the short term, to a moderate decline in the size of the middle class and an increase in poverty. As expected, these impacts vary by type of fuel and country (refer to annex C, figure C6). Although they are the most progressive fuel tax in relative terms, taxes on gasoline emissions are estimated to raise poverty in most countries. In Mexico, poverty incidence measured against the upper-middle-income line (US\$6.85 a day in 2017 PPP) is estimated to rise by 0.48 percentage points, from a baseline of 25.5 percent.²² This means around 615,378 vulnerable Mexicans would become poor because of the resulting 25 percent increase in the price of gasoline. In this case, the middle class would shrink by 0.61 percentage points, meaning 782,188 individuals would fall into vulnerability.²³ In most countries, the impact of gasoline prices tends to be larger on the middle class than on poverty, whereas the opposite is observed for LPG, which matters for the public acceptability of reforms and is consistent with the household expenditure patterns described above.

4.2. The welfare and distributional effects of increasing and aligning TCPs

The welfare and distributive effects of four carbon pricing reform scenarios are analyzed according to the insights in section 2 in examining TCPs in the LAC region. The analysis presumes that the reforms are fully implemented in the short term, rather than gradually over time. The specific reforms considered are as follows:

20 From an equity perspective, these patterns align with the rationale of policy makers in levying higher taxes on gasoline emissions while implementing reduced rates or even subsidies on LPG. Still, from an efficiency and environmental standpoint, there exist alternative fiscal instruments to provide more well targeted support to poor and vulnerable households.

21 The Kakwani index is a measure of the progressivity of a fiscal intervention. It is calculated as the difference between the concentration index for the tax and the Gini coefficient for pre-tax income (Kakwani, 1977). A positive value indicates progressivity, while a negative value indicates regressivity. A value of zero suggests proportionality, meaning that the tax burden is distributed in proportion to income.

22 This impact represents about 8 percent of the average annual change in poverty in Mexico in 2014–19. The same exercise in the case of Brazil results in an impact equal to 61 percent of the average annual poverty change during the same period.

23 Following the World Bank LAC Equity Lab, vulnerability is defined as the share of individuals whose per capita income is greater than US\$6.85, but below US\$14.00 a day (in 2017 purchasing power parity US dollars). The middle class refers to the share of individuals whose per capita income falls between US\$14.00 and US\$81.00 a day (2017 PPP). Refer to LAC Equity Lab: Poverty (dashboard), Equity Lab, Team for Statistical Development, World Bank, Washington, DC, <https://www.worldbank.org/en/topic/poverty/lac-equity-lab1/poverty#>.

- *Elimination of subsidies on fuel emissions*: evaluates the removal of explicit and implicit subsidies for fuel emissions, while maintaining the carbon price on other fuels constant at the baseline level. The objective of this reform is to eliminate fiscal incentives that promote the use of high emission energy sources.
- *Aligning carbon prices across fuels*: keeps the national average carbon price of fuel emissions constant at the baseline level, but introduces fuel-specific tax adjustments to ensure a uniform price per ton of CO₂ across all fuel types (Blanchard et al. 2023; OECD 2022).²⁴ The goal of this policy is to establish a consistent carbon price signal across energy sources by aligning tax rates with the fuel carbon content and, thus, eliminate incentives to switch across fuels.
- *Increase in the average carbon price of fuel emissions to US\$60 per ton of CO₂, while keeping heterogeneity across fuel types*: sets the national average carbon price at US\$60 per ton of CO₂, which is the low-end estimate for 2030 of the costs imposed by an additional ton of CO₂ released into the atmosphere (PMR 2017; OECD 2021). This scenario maintains the heterogeneity of carbon prices across fuel types in the baseline, resulting in a considerable carbon price gap between fuels.²⁵
- *Increase in the average carbon price of fuel emissions to US\$60 per ton of CO₂ by setting a uniform carbon price across all fuels*: raises the carbon price to US\$60 per ton of CO₂ for all fuel emissions. This is the most environmentally desirable scenario because it prices all fuel-related emissions at the same benchmark value that reflects the societal costs.

Carbon pricing reforms that raise the overall price of CO₂ emissions to the lower-end estimate of the associated costs (including social costs), that is, US\$60 per ton of CO₂, exert a negative income shock on most households, albeit of modest average size in the countries analyzed. Reforms that raise the nationwide carbon price to US\$60 per ton of CO₂, without altering relative carbon prices across fuels, would result in modest average per capita income losses, ranging between 0.2 percent and 1.2 percent (refer to figure 23).²⁶ These losses are considerably smaller than the average impact of annual inflation on household purchasing power in 2014–19. In Brazil, for example, increasing the national carbon rate to US\$60 per ton of CO₂ would result in an average decline of 0.99 percent in household income per capita in the short term, compared with an impact of 5.8 percent because of average annual inflation in 2014–19.²⁷ Average impacts may mask significant disparities, and the effects may be considerably larger among population groups that are more dependent on fuel use. In the countries analyzed, this specific reform increases the price of fuels between 1.5 and 18.3 percent (except for natural gas in Mexico)²⁸. However, the effect could be larger

24 Under this scenario, the price of CO₂ emissions does not vary across fuel types. The reference is to the price that, once weighted by fuel-specific CO₂ emissions, keeps the national average carbon price constant at the baseline. This implies that, while the carbon price for some fuels will increase with respect to the baseline scenario, it will decrease for others.

25 In this scenario, the carbon price for every fuel is increased by a fixed amount equal to the difference between the emissions-weighted average carbon price in the baseline scenario and the US\$60 per ton of CO₂ benchmark.

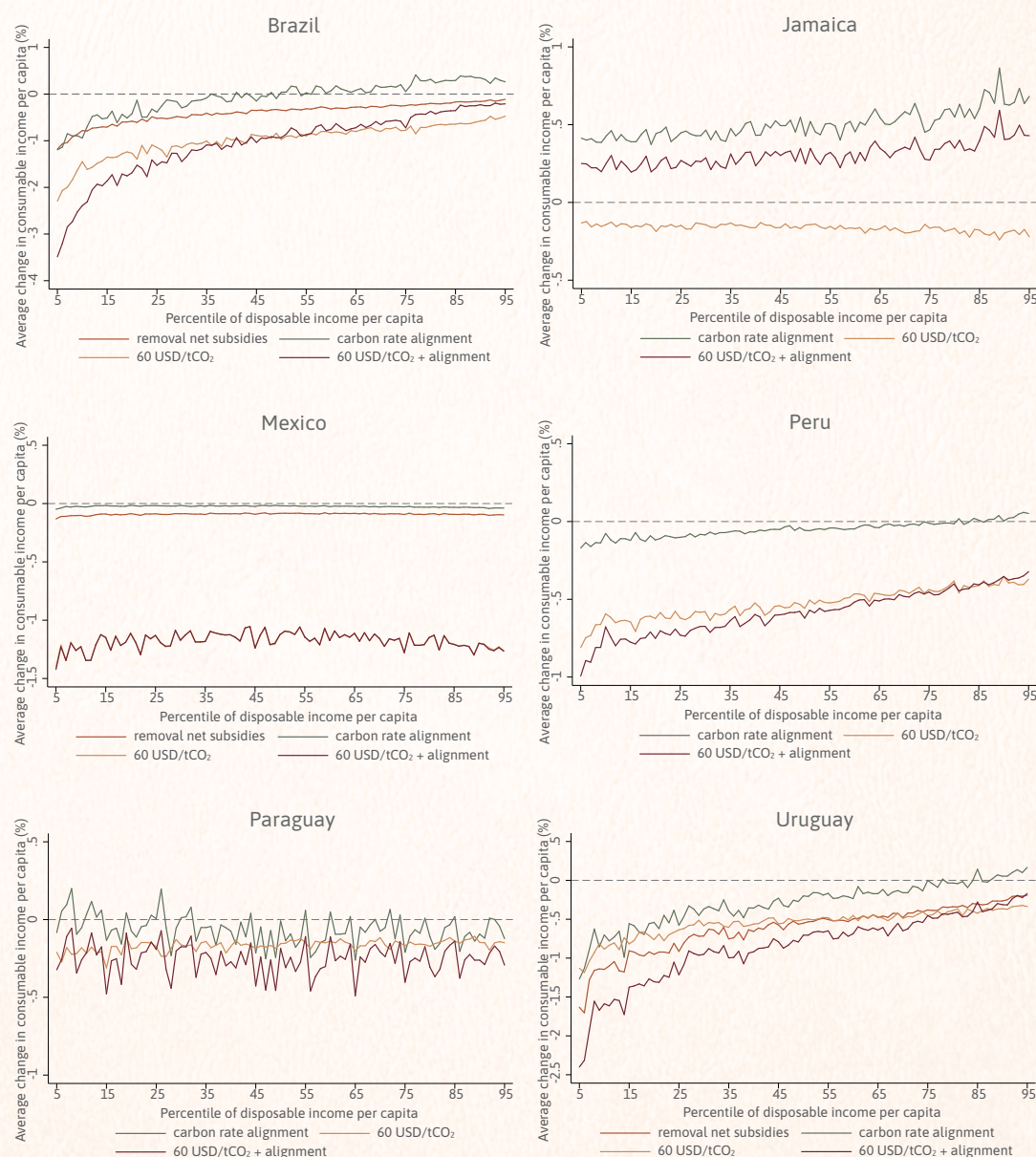
26 This scenario assumes that the increase in the country-level TCP to US\$60 per ton of CO₂ is achieved without altering the relative carbon price across fuels, that is, it is a parallel increase in the carbon price for all fuels by the same amount, starting from the existing levels (no alignment).

27 The estimated impacts of the carbon pricing reforms in Brazil and Uruguay are larger than in other countries because of the implied larger fuel price shocks, whereas they tend to be smaller in Peru.

28 Fuel price shocks, particularly for LPG and natural gas, tend to be larger under the reform scenario that aligns the TCP of all fuels to US\$60 per ton of CO₂, with LPG price increases approaching 30 percent in most of the countries analyzed.

with a higher target TCP (e.g. US\$120 per ton of CO₂) or for other countries where the same reform could result higher price shocks, due to differences in the current tax structure.²⁹

Figure 23. Estimated short-term income effects of selected fuel tax reforms (relative to the baseline scenario), by country



Source: World Bank calculations based on country-specific microsimulations.

Note: The figure shows the estimated percent change in per capita consumable income between the baseline and the simulated fuel tax reform scenarios for each country. The results are presented as the average across households for each percentile of the per capita disposable income distribution. Individuals in the bottom and top 5 percent of the disposable income distribution are excluded because of large data variations. In the case of Jamaica and Peru, the figure does not show the estimated effects of removing fuel subsidies because these countries do not have subsidies at the baseline. In Mexico, the US\$60 per ton of CO₂ scenarios (with and without carbon alignment) almost overlap because they have similar effects on household income. For more details, refer to annex C, table C2.

29 In Colombia, for example, the same reform would imply a fuel price shock ranging from 12 to 34 percent.

Reforms that align carbon prices across fuels are found to be more regressive relative to reforms that maintain the current heterogeneity in TCPs. Aligning tax rates with fuel carbon content would result in larger income losses among households at the bottom of the distribution and smaller income losses among households at the top, compared with the equivalent nonaligned scenarios.³⁰ In the case of simply aligning TCPs across fuels (without increasing the country-level TCP), the reform actually results in income gains among households at the top. This reflects a key feature of relative carbon prices in the region as discussed above. Because the gasoline TCP is positive and the highest, aligning TCPs to keep the overall country-level TCP constant would typically result in lower gasoline prices, largely benefiting wealthier households, while it would lead to significantly higher prices for LPG and diesel, disproportionately hurting the less well off.³¹ For example, in Uruguay, this reform is estimated to reduce per capita income by 0.76 percent among households at the bottom quintile compared with the baseline (no reform), while the reform is expected to increase income by 0.04 percent among households in the top quintile, leading to an increase in inequality of 0.13 Gini points (refer to annex C, figure C7).³²

Removing existing subsidies for fuel emissions entails larger per capita income losses compared with the alignment-only scenario, though it is a relatively more progressive policy. An obvious first step for the alignment of TCPs across fuels is the removal of fuel subsidies and tax exemptions. This policy simultaneously raises the overall carbon price on fuel emissions in the country and partially aligns carbon prices across fuels by bringing those that are untaxed closer to the rest. Given the current fuel tax and subsidy structure in the region (described in section 2), the removal of subsidies for fuel emissions typically results in an increase in the prices of LPG and diesel, while gasoline prices are often unaffected (because of their already higher TCP levels). In Brazil, Mexico, and Uruguay, removing subsidies would result in larger per capita income losses compared with the pure alignment scenario, particularly among higher-income households, which, under this subsidy reform scenario, would not benefit from potentially lower gasoline prices.

Despite their relatively limited average effects on household income, the analyzed reforms still exercise a modest negative impact on poverty and the middle class (refer to annex C, figure C7). The impact of the reforms on poverty does not exceed 0.6 percentage points, which is less than the median annual change in poverty rates in 2014–19 in the countries studied. Still, in the scenario by which the carbon price on all fuel emissions is aligned to US\$60 per ton of CO₂, the increase of 0.39 and 0.54 percentage points in the poverty headcount rate of Brazil and Mexico, for example, represents 812,790 and 689,608 new poor, respectively. In the case of the middle class, the impact of the reforms analyzed does not exceed 0.6 percentage points, observed in Mexico under that same policy reform scenario.

Compensatory measures can help reduce the negative short-term impacts of carbon price reforms on household purchasing power. How revenues from TCP reforms are used has

30 This refers, for example, to a comparison of scenario 4 relative to scenario 3 or scenario 2 against the baseline (horizontal axis).

31 In Jamaica, where the baseline carbon price is already high for several fuels (including diesel), the carbon alignment scenarios imply a reduction in the price of both gasoline and diesel, resulting in a positive income shock among households across the entire distribution because of the significant indirect price effects of diesel there.

32 Similar results are obtained in comparing the reform that increases the country-level TCP to US\$60 per ton of CO₂ without aligning across fuels (scenario 3) and the one that both increases and aligns the TCP to US\$60 per ton of CO₂ (scenario 4).

a first-order impact on welfare and distributional outcomes (Alonso and Kilpatrick 2022; Alvarez 2019; Garaffa et al. 2021; García-Muros, Morris, and Paltsev 2022; Goulder et al. 2019; Missbach, Steckel, and Vogt-Schilb 2022; Tovar-Reaños, Angel, and Lynch 2019). The potential additional fiscal resources generated by these reforms could be used, for example, to (1) reduce other taxes and contributions, such as labor taxes; (2) provide direct assistance to households by expanding well-targeted public transfers; (3) increase spending on public services (for instance, education and health care); or (4) design programs to facilitate the energy transition (such as programs for the purchase of electric stoves), particularly for poor and vulnerable households.³³ Such policies may reduce the overall burden of the reforms on households, while leaving the energy price signals to reduce emissions unaffected. Still, depending on the macroeconomic and fiscal context, governments may choose not to recycle the additional fiscal revenues and instead use them for fiscal consolidation.

Topping up existing targeted social assistance programs, for example, can offset the decline in household purchasing power. To illustrate the impacts of this measure, an additional scenario is modeled whereby individuals living in households benefiting from the main social assistance programs in each country receive a top-up that is equivalent to the average per capita income loss experienced by individuals in the bottom 40 under the scenario that aligns TCPs across all fuels to US\$60 per ton of CO₂. As expected, this mechanism alleviates income losses among lower-income households, but it has little impact on households in the middle of the distribution (refer to annex C, figure C8). In Uruguay, for example, top-ups to the Tarjeta Uruguay Social and Asignaciones Familiares del Plan de Equidad reduce average per capita income losses by 68 percent among households in the bottom quintile, while no changes are observed among households above the 54 percentile of the income distribution. In contrast, in Mexico, where programs are less targeted, this compensation mechanism also reduces income losses for individuals in the middle and upper parts of the income distribution. The efficiency and effectiveness of these progressive compensatory policies depend on having a strong social protection system and well-targeted programs in place.

Effective compensation for energy reform requires targeted policies, broader support measures, and strategic links to other areas to reduce opposition. Identifying the groups that are particularly affected and the characteristics of these groups to target compensation policies and the communication of the policies is crucial. Moreover, because compensation policies are usually targeted on the lower end of the distribution, they have little effect on other population segments. It is thus important to consider other complementary policies that may help attract support for reforms, such as actions to enable households to adopt sustainable consumption and investment practices, such as increased public transport connectivity and improved electricity accessibility, affordability, and reliability. There are also good arguments for designing policy packages that encourage consensus around energy tax and subsidy reform by linking the reform to actions in other areas, for example, investments to improve security, education, or health services.

33 The first of these, reducing other taxes and contributions, such as labor taxes, is commonly known as the double-dividend approach because of its potential to reduce emissions (first dividend) and reduce other, more distortionary taxes that slow economic growth (second dividend). Still, this might not be the most effective mechanism to compensate low-income households given that they are more likely to engage in informal jobs, and their income tends to fall below the minimum taxable threshold.

5

CONCLUDING REMARKS AND THE FUTURE AGENDA FOR POLICY AND RESEARCH



A rapidly evolving fiscal, energy, social, and political landscape calls for a revision of the way the LAC countries tax and subsidize energy. Avoiding the inertia that tends to favor maintaining existing energy taxes and subsidies is arguably more important now than in recent decades. The technological change occurring in the energy sector is a salient structural trend. The disruption created by renewable electricity technologies that can compete on costs with fossil fuels is the leading development in this area. Other sectors, such as transport, are not at the same level of maturity, but their evolution has the potential to be as technologically relevant. At the same time, countries in the region need to strengthen their fiscal positions and collect resources to close the gap in areas such as education or infrastructure. Improvements in social protection systems mean that the arguments that traditionally justified subsidies on fossil fuels because of their pro-poor and pro-equity benefits are now mostly discredited. The geopolitics of fossil fuels are now, after the Russian invasion of Ukraine and other ongoing tensions, much more uncertain. Finally, but critically, the transformation of energy systems is necessary to achieve the climate commitments of the LAC countries under the Paris Agreement.

While various factors shape consumer and firm energy-related decisions and, thus, the transformation of energy systems, prices have a central role. Prices are fundamental in energy policy, as they drive energy intensity, the energy mix, and energy-related capital investments. Policies aimed at steering the modernization of energy systems in the LAC region are therefore unlikely to succeed without establishing appropriate price signals. Energy taxes and subsidies are key policy tools for influencing energy prices and creating incentives to accelerate the energy transformation. However, these policies must be complemented by other measures because of the complexity of the challenge and other barriers, such as imperfect information, the lack of hedging instruments, and political and social viability, that prevent a strategy focused solely on prices from achieving the desired results.

In designing energy tax reforms, it is critical to consider all fiscal instruments and their combined effects on energy prices. In most LAC countries, excise taxes, tax exemptions, subsidies, and prices regulations add to the traditional tax structure on energy prices. Direct carbon pricing instruments, such as carbon taxes and ETSSs, are a recent addition to the toolkit of policy makers, though their application remains limited in the region. Any policy reform that ignores the interactions between the different tax and subsidy instruments and their net effect on energy prices and incentives is unlikely to provide the right price signals. This is why adopting a comprehensive framework, such as the TCP framework used in this report, is essential. TCPs capture the combined impact of taxes and subsidies on the relative price of each fossil fuel, expressed in terms of the respective CO₂ emissions.

The current energy tax and subsidy structure in the region results in positive economy-wide TCPs, though these fall below international benchmarks and are not aligned across fuels. Overall, LAC countries show positive TCPs. These have recovered since the discontinuation of the exceptional measures taken to counteract the 2022 global energy price shock. These TCPs are mainly driven by fuel excise taxes, while direct carbon price instruments remain less significant or absent in some countries. These energy tax instruments coexist with subsidies, which reduce the overall price signals. In 2023, economy-wide TCPs remained below US\$60 per ton of CO₂ in most countries, which is a common benchmark for the costs of carbon emissions and the price needed to create incentives for energy transformation and climate change mitigation. In addition, there is substantial heterogeneity in TCPs across fuel types.

TCP estimates for 11 LAC countries in 2017–23 show common misalignments. First, gasoline emissions are taxed at relatively high rates, while diesel emissions are taxed at a much lower rate, despite diesel's more harmful health effects. Second, natural gas and LPG are either untaxed or subsidized.

This structure delays the adoption of technological changes in the energy sector and creates risks for countries in the region, such as dependence on fuel imports. Lower taxes on diesel, natural gas, and LPG incentivize excessive use. These price incentives created by the fiscal system delay feasible technological alternatives and create vulnerabilities for LAC countries. Cheap diesel not only prolongs the use of old, inefficient, and insecure vehicles, but it also creates a dependency on imports and increases air pollution in the region's congested cities. Fiscal incentives promoting natural gas demand, mostly inherited from an era when no more efficient or cleaner technological alternatives existed, hinder the adoption of renewable electricity. In the case of LPG, subsidies have been justified on equity grounds to support poorer households in using cleaner cooking fuels and transitioning away from harmful solid fuels such as firewood and coal. Nonetheless, universal subsidies are an inefficient tool for addressing the needs of most vulnerable households and deter the adoption of new, modern cooking and heating technologies suitable for conditions in the region.

Aligning energy taxes with the carbon content of fuels is a sound policy that offers benefits beyond climate considerations. An extensive literature indicates that strong energy price signals are an effective tool for reducing greenhouse gas emissions, helping countries in the region move closer to meeting their Paris Agreement commitments. Reducing emissions is crucial for mitigating climate change and its impacts on the planet. Given the emphasis in this report on the technological and fiscal dimensions and the recognition that energy taxation is guided by many factors other than mitigation, it may seem surprising that the most fundamental recommendation is still aligning energy taxes with the cost of the carbon in each fuel. Once the full effects of all taxes and subsidies are computed in terms of their carbon content, it becomes clear that LAC countries are insufficiently taxing or subsidizing the fuels that are responsible for most of their emissions. The main fiscal benefits will thus accrue simply from reversing this situation. Moreover, even if the climate dimension is set aside, strong and consistent carbon prices provide the appropriate incentives for driving the modernization and technological transformation of key sectors, including electricity generation, transportation, and residential cooking and heating.

Reforming energy taxes and subsidies can generate much needed fiscal revenues. Most countries in the region need to strengthen their public finances, which have considerably deteriorated since the Covid-19 pandemic. This calls for improvements in the efficiency of tax and expenditure instruments. There seems to be growing consensus, following the exceptional measures of 2022, that the region spends too much on making certain fuels artificially cheap and that these limited resources would be more effective if they were allocated to other priority areas, such as education, health care, or security. The results in this report suggest that eliminating subsidies and gradually increasing energy taxes could yield substantial fiscal resources. For instance, additional fiscal revenue, estimated at 0.5 percent of GDP in 2030, would be created by a reform that gradually increases the carbon price to US\$60 per ton of CO₂ for all fuels, a level that appears reasonable for the region, though some countries may opt for higher or lower targets.

A key question for governments considering these types of reforms is the macroeconomic trade-offs involved, particularly the short-term impact on growth. Simulations conducted in this report suggest that the growth impacts could be manageable. In countries where revenue recycling is an option, increasing public spending or reducing other taxes could help achieve neutral or slightly positive effects on aggregate income. For many LAC countries, however, the full recycling of energy tax revenues may not be feasible because of the need for fiscal consolidation. In such cases, the results suggest the impacts on economic activity would be moderate, indeed, they are expected to be smaller than those associated with other tax options. Comparing fiscal multipliers across different tax instruments is an area where further research is needed. In the design of energy tax reforms, gradual and predictable changes are preferable. Households and firms require time to adjust and realize the incentives for investment in the transformation of energy use. This approach also helps limit the potential for sudden impacts on economic activity and household welfare. Overall, the simulations in this report suggest that the main challenges in the approval of subsidy or energy tax reforms are political, rather than macroeconomic.

Understanding the welfare and distributional impacts of TCP reforms is crucial to ensuring their successful implementation. The analysis presented in this report shows that aligning fuel tax rates with emissions content and increasing the carbon price on fuel emissions at once, reduces household purchasing power in the short term. The effects vary across households, reforms, and countries. For the countries considered, the estimated per capita income effects have been found to be modest and below the average impact of annual inflation in 2014–19 on household purchasing power in these countries. This results in a moderate negative effect on the poverty incidence and the size of the middle class. Still, in populous countries such as Brazil and Mexico, this means that hundreds of thousands of individuals could fall into poverty and become vulnerable as a result of the TCP reforms. Also, average income impacts mask important disparities, as effects are considerably larger among population groups that are more dependent on fuel use.

Energy taxes (subsidies) are largely paid (received) by the middle class and the wealthy, but they have a higher impact on the purchasing power of the less well off, particularly in the case of LPG taxes. Gasoline taxes tend to have the largest average impacts (because of higher household spending shares on this fuel), but tend to matter less among poorer households, while, in the case of LPG taxes, the reverse tends to be true. The latter taxes are thus more regressive. Although diesel is not used directly by most households, taxes on diesel emissions impact the costs of the production and distribution of goods, including food, which disproportionately impacts lower-income households. These results have important implications for TCP reforms aimed at aligning the taxation of fuels with their emission content. Generally, these reforms tend to have slightly more regressive impacts because, at least partially, low taxes and subsidies for energy are concentrated on fuels that are more important for poorer households.

Compensation through existing well-targeted social protection programs can help offset the impacts on the less well off, reducing income losses by almost half among those at the bottom of the distribution, but this may not be sufficient to prevent opposition to the reforms. An illustrative example is the case of Uruguay, where compensation through

existing social protection programs reduces losses among households in the bottom quintile successfully, while preserving energy price signals and their impact on incentives. However, these programs do little to compensate the middle class and other affected population groups, reinforcing the need for additional policy measures. Also, the efficiency and effectiveness of such policies depend on the strength and coverage of the social protection system in place. The choice of revenue recycling mechanisms is crucial to public acceptance and addressing socioeconomic disparities in the long term.

Energy tax reforms must be considered in conjunction with other sectoral reforms; this is key to their success. The effectiveness of energy reforms in driving energy transformation will depend on conditions in various sectors, including factors such as the technological maturity of feasible energy alternatives, the quality of regulation, and the availability of finance. Energy tax and subsidy reforms are therefore more likely to succeed if they are integrated into a broader policy package that addresses sector-specific challenges, allowing for the optimization of synergies between tax incentives and other policy tools. For example, in the electricity generation sector, there are strong complementarities between energy taxes and dispatch rules, which can incentivize private investors to install new capacity in response to price and profitability signals. In the transport sector, regulations affecting public transportation are critical for the adoption of electric buses, which are already competitive under adequate market designs. The expansion of support programs for low-income households to facilitate the adoption of electrified cooking equipment is a promising area. Designing comprehensive policy roadmaps helps overcome political constraints by fostering multidimensional agreements with the most affected stakeholders.

A useful research agenda for policy might focus on understanding the advantages and disadvantages of energy taxation compared with other fiscal tools, as well as examining the behavioral changes among households and firms in response to tax reforms. During the elaboration of this report, several areas were identified on which more research is needed to support effective policy making. First, much of the research on energy taxes and subsidies has a strong climate focus, which is understandable given the relevance of this challenge, but it leaves other important areas understudied. There is a gap in studies that place energy taxes and subsidies within the broader spectrum of tax instruments available to policymakers. For example, there is limited evidence on the relative size of energy tax multipliers compared with VATs, personal income taxes, or corporate income taxes. The competitiveness implications of energy taxes, often cited as a factor discouraging these reforms, are also underexplored. In addition, many macroeconomic models used by ministries of finance lack detailed representations of energy taxes and subsidies, meaning that simulations of fiscal and macroeconomic outcomes from their reform can only provide approximate results. Second, there is still insufficient evidence on how firms and households react to energy prices at the microlevel, and how these reactions drive macroeconomic outcomes. For example, further evidence on how firms cope with energy price shocks and whether their responses differ if they are faced with tax-induced price shocks would be invaluable in the debates around TCP reforms. Similarly, studies identifying the changes in household consumption behavior in response to energy price shocks in both the short and the long term would be extremely informative. Several studies are starting to move in this direction, including the work of Amman and Grover (2023), but results remain scarce on the LAC countries.

This report is based on the premise that energy taxes and subsidies are crucial for sustainable development and should be an integral part of the energy and fiscal policy strategies in LAC countries, despite the inherent challenges of reform. The political economy of tax reforms is always complex, and energy taxes and subsidies are probably among the most sensitive areas. Many policymakers view energy tax reforms as politically impossible. Yet, the region has seen significant advances in this area in recent years. The rapid reversal of the additional fuel subsidies introduced in 2022 in most LAC countries, the increase in the carbon tax in Chile, and recent efforts toward energy subsidy reform in several LAC countries (such as Argentina, Colombia, and Ecuador) demonstrate that energy taxes and subsidies can be reformed. They also show that the processes leading to these reforms are complex and far more multidimensional than usually recognized. Climate mitigation objectives, while important, are not the only, nor necessarily the most relevant drivers of these reforms. Fiscal pressures, inflation dynamics, international policy agendas, and a host of other factors all influence how and when energy tax reforms are implemented. Despite this complexity, keeping a focus on carbon prices and aligning energy taxes with each fuel's carbon content should be a key consideration in these reforms.

6

REFERENCES



Acharya, Bikram, and Klaus Marhold. 2019. "Determinants of Household Energy Use and Fuel Switching Behavior in Nepal." *Energy* 169 (February): 1132–38.

Paolo Agnolucci, Defne Gencer, and Dirk Heine. 2024. Total carbon pricing for energy consumption: The importance of energy taxes and subsidies. Energy Subsidy Reform in Action Series. ESMAP Technical Report. Washington, DC: World Bank. License: Creative Commons Attribution CC BY 3.0 IGO.

Agnolucci, Paolo, Carolyn Fischer, Dirk Heine, Mariza Montes de Oca Leon, Joseph Dixon Callisto Pryor, Kathleen Patroni, and Stéphane Hallegatte. 2023. "Measuring Total Carbon Pricing." Policy Research Working Paper 10486, World Bank, Washington, DC.

Alatorre, José Eduardo, Karina Caballero, Jimmy Ferrer, and Luis Miguel Galindo. 2019. "El costo social del carbono: una visión agregada desde América Latina." Documento de Proyectos, Economic Commission for Latin America and the Caribbean, Santiago, Chile. <https://hdl.handle.net/11362/44423>.

Alonso, Cristian, and Joey Kilpatrick. 2022. "The Distributional Impact of a Carbon Tax in Asia and the Pacific." IMF Working Paper WP/22/116 (June), International Monetary Fund, Washington, DC.

Alvarez, Maximiliano. 2019. "Distributional Effects of Environmental Taxation: An Approximation with a Meta-Regression Analysis." *Economic Analysis and Policy* 62 (June): 382–401.

Amann, Juergen, and Arti Grover. 2023. "The Effects of Energy Prices on Firm Competitiveness: Evidence from Chile." Policy Research Working Paper 10436, World Bank, Washington, DC.

Araar, Abdelkrim, and Paolo Verme. 2016. "Prices and Welfare." Policy Research Working Paper 7566, World Bank, Washington, DC.

Arlinghaus, Johanna. 2015. "Impacts of Carbon Prices on Indicators of Competitiveness: A Review of Empirical Findings." OECD Environment Working Paper 87 (March), Organisation for Economic Co-operation and Development, Paris.

Ayres, Robert U., Jeroen C.J.M. vanden Bergh, Dietmar Lindenberger, and Benjamin Warr. 2013. "The Underestimated Contribution of Energy to Economic Growth." *Structural Change and Economic Dynamics* 27 (December): 79–88. <https://doi.org/10.1016/j.strueco.2013.07.004>.

Beck, Marisa, Nicholas Rivers, Randall Wigle, and Hidemichi Yonezawa. 2015. "Carbon Tax and Revenue Recycling: Impacts on Households in British Columbia." *Resource and Energy Economics* 41 (August): 40–69.

Beylis, Guillermo, and Barbara Cunha. 2017. Energy Pricing Policies for Inclusive Growth in Latin America and the Caribbean. Directions in Development. Washington, DC: World Bank. doi:10.1596/978-1-4648-1111-1. License: Creative Commons Attribution CC BY 3.0 IGO.

Bianchi Alves, Bianca, Lama Bou Mjahed, and Joanna Moody. 2023. Decarbonizing Urban Transport for Development. Mobility and Transport Connectivity Series. Washington, DC: Transport Global Practice, World Bank.

- Black, Simon, Ian W. H. Parry, Victor Mylonas, Nate Vernon, and Karlygash Zhunussova. 2023. "The IMF–World Bank Climate Policy Assessment Tool (CPAT): A Model to Help Countries Mitigate Climate Change." IMF Working Paper WP/23/128 (June), International Monetary Fund, Washington, DC.
- Blanchard, Olivier J., Christian Gollier, and Jean Tirole. 2023. "The Portfolio of Economic Policies Needed to Fight Climate Change." *Annual Review of Economics* 15 (1): 689–722.
- Borissov, Kirill, Alexandra Brausmann Vinogradova, and Lucas Bretschger. 2019. "Carbon Pricing, Technology Transition, and Skill-Based Development." *European Economic Review* 118 (September): 252–69.
- Briceño-Garmendia, Cecilia, Wenxin Qiao, and Vivien Foster. 2023. *The Economics of Electric Vehicles for Passenger Transportation*. Sustainable Infrastructure Series. Washington, DC: World Bank.
- Burda, Michael C., Anna-Maria Göth, and Leopold Zessner-Spitzenberg. 2025. "Capital Adjustment Costs and Stranded Assets in an Optimal Green Energy Transition." Work in progress, Humboldt University, Berlin.
- Campmas, Alexandra, Sahil Gill, J. Al-Rikabi, and D. Bastidas. 2024. PFR fundamentals: Total carbon price 2.0. Working Paper.
- Carbone, Jared C., Nicholas Rivers, Akio Yamazaki, and Hidemichi Yonezawa. 2020. "Comparing Applied General Equilibrium and Econometric Estimates of the Effect of an Environmental Policy Shock." *Journal of the Association of Environmental and Resource Economists* 7 (4): 687–719.
- EIA (US Energy Information Administration). 2023. "Short-Term Energy Outlook, STEO." June, EIA, Washington, DC.
- Fay, Marianne, Luis Alberto Andres, Charles Fox, Ulf Narloch, Stephane Straub, and Michael Slawson. 2017. "Rethinking Infrastructure in Latin America and the Caribbean: Spending Better to Achieve More." World Bank, Washington, DC.
- Fleischhaker, Cornelius; Navia, Daniel; Rios, Heron. 2024. "Providing Better Price Signals Through Fuel Taxation: Opportunities in Brazil's Consumption Tax Reform". Prosperity Insight Series. World Bank, Washington, DC.
- Foster, Vivien, Jennifer Uju Dim, Sebastian Vollmer, and Fan Zhang. 2021. "Understanding Drivers of Decoupling of Global Transport CO₂ Emissions from Economic Growth: Evidence from 145 Countries." Policy Research Working Paper 9809, World Bank, Washington, DC.
- Fullerton, Don. 2011. "Six Distributional Effects of Environmental Policy." NBER Working Paper 16703 (January), National Bureau of Economic Research, Cambridge, MA.
- Garaffa, Rafael, Bruno S. L. Cunha, Talita Cruz, Paula Bezerra, André F. P. Lucena, and Angelo C. Gurgel. 2021. "Distributional Effects of Carbon Pricing in Brazil under the Paris Agreement." *Energy Economics* 101 (September), 105396.

García-Muros, Xaquín, Jennifer Morris, and Sergey Paltsev. 2022. "Toward a Just Energy Transition: A Distributional Analysis of Low-Carbon Policies in the USA." *Energy Economics* 105 (January), 105769.

Göth, Anna-Maria, and Leopold Zessner-Spitzenberg. 2025. "Anchoring Carbon Price Expectations." Work in progress, Humboldt University, Berlin.

Göth, Anna-Maria, Leopold Zessner-Spitzenberg, and Carolyn Fischer. 2025. "Capital Adjustment Costs and Nationally Determined Contributions: How to Avoid Double Transitions of Energy Capital?" Paper presented at the ASSA 2025 Annual Meeting, San Francisco, January 3–5, 2025.

Goulder, Lawrence H., Marc Andrew Christian Hafstead, GyuRim Kim, and Xianling Long. 2019. "Impacts of a Carbon Tax across US Household Income Groups: What Are the Equity-Efficiency Trade-Offs?" *Journal of Public Economics* 175 (July): 44–64.

Grubb, Michael, Igor Bashmakov, Paul Drummond, Anna Myshak, Nick Hughes, Andrea Biancardi, Paolo Agnolucci, and Robert Lowe. 2018. "An Exploration of Energy Cost, Ranges, Limits, and Adjustment Process." Research Report (March), UCL Energy Institute, UCL Institute for Sustainable Resources, University College London, London.

Hanson, Gordon H. 2023. "Local Labor Market Impacts of the Energy Transition: Prospects and Policies." NBER Working Paper 30871 (January), National Bureau of Economic Research, Cambridge, MA.

Harding, Michelle. 2014. "The Diesel Differential: Differences in the Tax Treatment of Gasoline and Diesel for Road Use." OECD Taxation Working Papers 21, OECD Centre for Tax Policy and Administration, Organisation for Economic Co-operation and Development, Paris. <https://doi.org/10.1787/5jz14cd7hk6b-en>.

HEI (Health Effects Institute). 2024. "State of Global Air 2024." Special Report, HEI, Boston.

Hill, Ruth Vargas, Trang Nguyen, and Miki Khanh Doan. 2024. "Climate and Equity: A Framework to Understand Welfare Impacts and Guide Policy Action." Prosperity Insight Series, World Bank, Washington, DC.

IEA (International Energy Agency). 2023a. "Cost of Capital Observatory." Report (November), IEA, Paris. <https://www.iea.org/reports/cost-of-capital-observatory>.

IEA (International Energy Agency). 2023b. "Latin America Energy Outlook." World Energy Outlook Special Report (November), IEA, Paris. <https://www.iea.org/reports/latin-america-energy-outlook-2023>.

IEA (International Energy Agency). 2024a. "Strategies for Affordable and Fair Clean Energy Transitions." World Energy Outlook Special Report (May), IEA, Paris. <https://www.iea.org/reports/strategies-for-affordable-and-fair-clean-energy-transitions>.

IEA (International Energy Agency). 2024b. "World Energy Outlook 2024." Report (October), IEA, Paris. <https://www.iea.org/reports/world-energy-outlook-2024>.

IMF (International Monetary Fund). 2021. "Group of Twenty: Reaching Net Zero Emissions." G20 Note (June), International Monetary Fund, Washington, DC. elnchauste, Gabriela, Karolina Goraus, and Haydeeliz Carrasco. 2022. "The Distributional Incidence of VAT in the Context of Informality." World Bank, Washington, DC.

Kakwani, Nanak Chand. 1977. "Measurement of Tax Progressivity: An International Comparison." *Economic Journal* 87 (345): 71-80.

Kaufman, Noah, Alexander R. Barron, Wojciech Krawczyk, Peter Marsters, and Haewon McJeon. 2020. "A Near-Term to Net Zero Alternative to the Social Cost of Carbon for Setting Carbon Prices." *Nature Climate Change* 10 (11): 1010-14. <https://doi.org/10.1038/s41558-020-0880-3>.

Kojima, Masami. 2021. "Primary Household Energy for Cooking and Heating in 52 Developing Economies." June, Energy Sector Management Assistance Program, World Bank, Washington, DC.

Koomey, Jonathan Stephen Berard, Marla Sanchez, and Henry Wong. 2011. "Implications of Historical Trends in the Electrical Efficiency of Computing." *IEEE Annals of the History of Computing* 33 (3): 46-54.

Köppl, Angela, and Margit Schratzenstaller. 2023. "Carbon Taxation: A Review of the Empirical Literature." *Journal of Economic Surveys* 37 (4): 1353-88. <https://doi.org/10.1111/joes.12531>.

Labandeira, Xavier, José M. Labeaga, and Miguel Rodríguez. 2009. "An Integrated Economic and Distributional Analysis of Energy Policies." *Energy Policy* 37 (12): 5776-86.

Lustig, Nora Claudia, ed. 2022a. *Fiscal Incidence Analysis: Methodology, Implementation, and Applications*. Vol. 1 of *Commitment to Equity Handbook: Estimating the Impact of Fiscal Policy on Inequality and Poverty*, 2nd ed. New Orleans: CEQ Institute, Tulane University; Washington, DC: Brookings Institution Press.

Lustig, Nora Claudia, ed. 2022b. *Methodological Frontiers in Fiscal Incidence Analysis*. Vol. 2 of *Commitment to Equity Handbook: Estimating the Impact of Fiscal Policy on Inequality and Poverty*, 2nd ed. New Orleans: CEQ Institute, Tulane University; Washington, DC: Brookings Institution Press.

Mayer, Jakob, Anna Dugan, Gabriel Bachner, and Karl W. Steininger. 2021. "Is Carbon Pricing Regressive? Insights from a Recursive-Dynamic CGE Analysis with Heterogeneous Households for Austria." *Energy Economics* 104 (December), 105661.

Missbach, Leonard, Jan Christoph Steckel, and Adrien Vogt-Schilb. 2022. "Cash Transfers in the Context of Carbon Pricing Reforms in Latin America and the Caribbean." IDB Working Paper IDB-WP-01404 (November), Inter-American Development Bank, Washington, DC.

Moerenhout, Tom, Defne Gencer, Beatriz Arizu, Min A. Lee, and Hannah Braun. 2024. "Political Economy Analysis and Communications for Energy Subsidy Reforms: Approaches and Insights from Recent Technical Assistance." Technical Report (March), Energy Subsidy Reform in Action Series, World Bank, Washington, DC.

Mukherjee, Anit, Yuko Okamura, Ugo Gentilini, Defne Gencer, Mohamed Almenfi, Adea Kryeziu, Miriam Montenegro, and Nithin Umapathi. 2023. “Cash Transfers in the Context of Energy Subsidy Reforms: Insights from Recent Experience.” Technical Report (July), Energy Subsidy Reform in Action Series, World Bank, Washington, DC.

OECD (Organisation for Economic Co-operation and Development). 2021. “Effective Carbon Rates 2021: Pricing Carbon Emissions through Taxes and Emissions Trading.” OECD, Paris.

OECD (Organisation for Economic Co-operation and Development). 2022. “Pricing Greenhouse Gas Emissions: Turning Climate Targets into Climate Action.” OECD Series on Carbon Pricing and Energy Taxation, OECD, Paris.

OECD (Organisation for Economic Co-operation and Development). 2023. “Effective Carbon Rates 2023: Pricing Greenhouse Gas Emissions through Taxes and Emissions Trading.” OECD Series on Carbon Pricing and Energy Taxation, OECD, Paris.

Parry, Ian W. H., Simon Black, and James Roaf. 2021. “Proposal for an International Carbon Price Floor among Large Emitters,” IMF Staff Climate Note 2021/001 (June), International Monetary Fund, Washington, DC.

Parry, Ian W. H., Simon Black, and Karlygash Zhunussova. 2022. “Carbon Taxes or Emissions Trading Systems? Instrument Choice and Design.” IMF Staff Climate Note 2022/006 (July), International Monetary Fund, Washington, DC.

Pigato, Miria A., ed. 2019. *Fiscal Policies for Development and Climate Action*. International Development in Focus Series. Washington, DC: World Bank. <https://doi.org/10.1596/978-1-4648-1358-0>.

PMR (Partnership for Market Readiness). 2017. *Carbon Tax Guide: A Handbook for Policymakers*. March. Washington, DC: World Bank.

Ramey, Valerie A. 2019. “Ten Years after the Financial Crisis: What Have We Learned from the Renaissance in Fiscal Research?” *Journal of Economic Perspectives* 33 (2): 89–114.

Rausch, Sebastian, Gilbert E. Metcalf, and John M. Reilly. 2011. “Distributional Impacts of Carbon Pricing: A General Equilibrium Approach with Micro-Data for Households.” *Energy Economics* 33 (Supplement 1): S20–S33.

Ravillard, Pauline, Enrique Chueca, Mariana Weiss, Alberto Levy, Mauricio Tolmasquim, and Michelle Hallack. 2023. “Removing Barriers to Clean Cooking Programs in Latin America.” *Energy for Sustainable Development* 73 (April): 247–62. <https://doi.org/10.1016/j.esd.2023.02.006>.

Renner, Sebastian, Jann Lay, and Hannes Greve. 2018. “Household Welfare and CO2 Emission Impacts of Energy and Carbon Taxes in Mexico.” *Energy Economics* 72 (May): 222–35.

Schoder, Christian. 2023. “Regime-Dependent Environmental Tax Multipliers: Evidence from 75 Countries.” *Journal of Environmental Economics and Policy* 12 (2): 124–67. <https://doi.org/10.1080/21606544.2022.2089238>.

- Smil, Vaclav. 2017. *Energy and Civilization: A History*. Cambridge, MA: MIT Press.
- Stern, David I. 2011. "The Role of Energy in Economic Growth." *Annals of the New York Academy of Sciences* 1219 (1): 26–51. <https://doi.org/10.1111/j.1749-6632.2010.05921.x>.
- Stern, Nicholas, Joseph E. Stiglitz, and Charlotte Taylor. 2022. "The Economics of Immense Risk, Urgent Action, and Radical Change: Towards New Approaches to the Economics of Climate Change." NBER Working Paper 28472 (February), rev. ed. National Bureau of Economic Research, Cambridge, MA. <http://www.nber.org/papers/w28472>.
- Strand, Jon. 2025. "Deriving Optimal Taxes for Gasoline, Diesel and Ethanol for Brazil." World Bank, Washington, DC.
- Tovar-Reaños, Miguel Angel, and Muireann Á. Lynch. 2019. "Distributional Impacts of Carbon Taxation and Revenue Recycling: A Behavioral Microsimulation." ESRI Working Paper 626 (June), Economic and Social Research Institute, Dublin.
- Wang, Qian, Klaus Hubacek, Kuishuang Feng, Lin Guo, Kun Zhang, Jinjun Xue, and Qiao-Mei Liang. 2019. "Distributional Impact of Carbon Pricing in Chinese Provinces." *Energy Economics* 81 (June): 327–40.
- Wang, Qian, Klaus Hubacek, Kuishuang Feng, Yi-Ming Wei, and Qiao-Mei Liang. 2016. "Distributional Effects of Carbon Taxation." *Applied Energy* 184 (December): 1123–31.
- WHO (World Health Organization). 2024. "Household Air Pollution." *Fact Sheet*, October 16, 2024. <https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health>.
- Winkler, Hernán Jorge, Vincenzo Di Maro, Kelly Yelitza Montoya Munoz, Sergio Daniel Olivieri, and Emmanuel Jose Vazquez. 2024. "Measuring Green Jobs: A New Database for Latin America and Other Regions." Policy Research Working Paper 10794, World Bank, Washington, DC.
- World Bank. 2019. "Green Your Bus Ride: Clean Buses in Latin America." Summary report (January), World Bank, Washington, DC.
- World Bank. 2022a. *China: Country Climate and Development Report*. October. Washington, DC: World Bank.
- World Bank. 2022b. "Consolidating the Recovery: Seizing Green Growth Opportunities." Semiannual Report for Latin America and the Caribbean, April, World Bank, Washington, DC. <https://doi.org/10.1596/978-1-4648-1867-7>.
- World Bank. 2024a. *Carbon Pricing in the Power Sector: Role and Design for Transitioning toward Net-Zero Carbon Development*. Washington, DC: World Bank. <https://doi.org/10.1596/42091>.
- World Bank. 2024b. *Taxing Wealth for Equity and Growth*. Latin America and the Caribbean Economic Review (October). Washington, DC: World Bank.
- Yergin, Daniel. 2020. *The New Map: Energy, Climate, and the Clash of Nations*. New York: Penguin Press.

7

ANNEXES



Annex A.

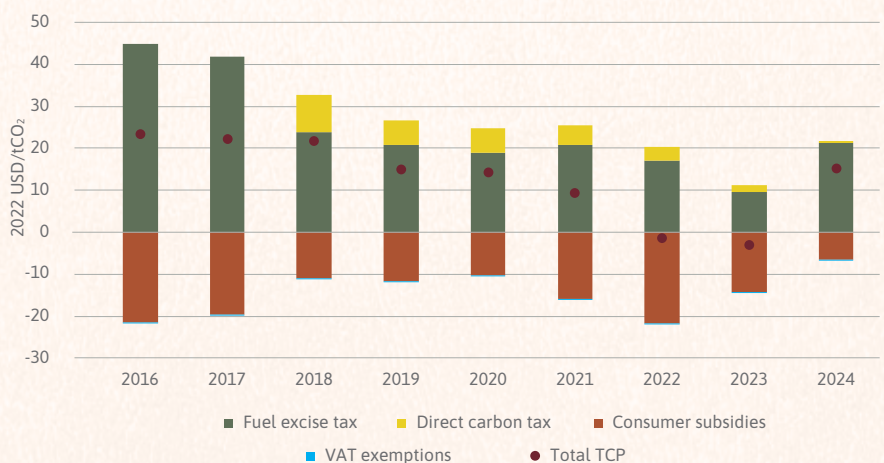
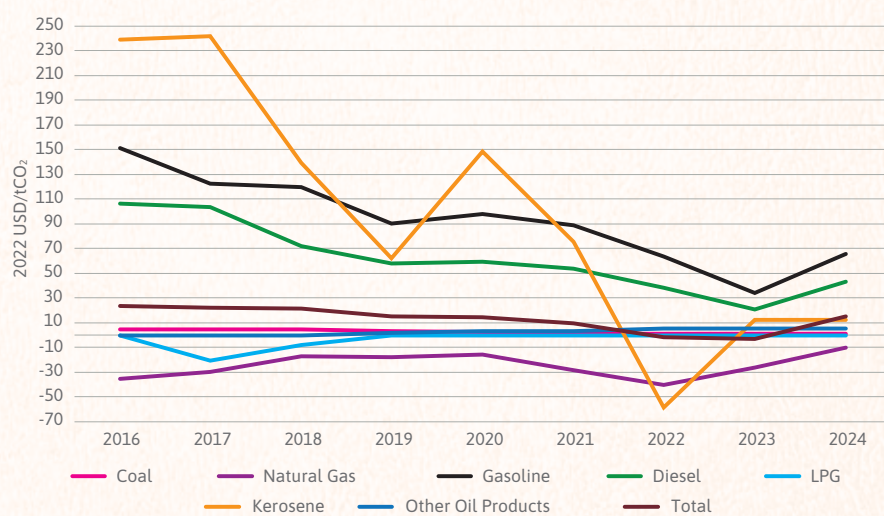
Country detailed estimates by fuel and by fiscal instrument

Notes: In the figures and tables below, for each country, total TCP is the weighted average of each fuel by the share of that fuel's emissions over the country's total CO₂ emissions from fuel combustion (see the last line of the table or the red line/dots in the figures). TCP values for 2024 for MEX, COL, CHL, URY, ARG are estimated using data up to August 2024. For each country's details of methodology and sources, please refer to the country-specific methodology notes. Data on CO₂ emissions from fuel combustion by fuel and by sector comes from the IEA's World Energy Balances converted into emissions using IEA's standard emission factors.

For each fuel, the last column of the tables below shows the emission weight as the share of each fuel's CO₂ emission in that country over total fuel CO₂ in LAC (considering only the countries in this study). These emission weights were used to build the regional LAC average TCP by fuel shown in Section 2. Emission weight values reported are the last year available published (2022). Data on emission shares is built by using IEA's WEB energy consumption data (which goes up to 2022, so values for 2023 and 2024 are taken as constant from 2022) and converted into emissions using IEA's conversion factors for most countries, with the exception of PRY, URY, DMA and LCA, where emission data came from national sources directly.

Argentina TCP³⁴, 2022 US dollars per ton of CO₂

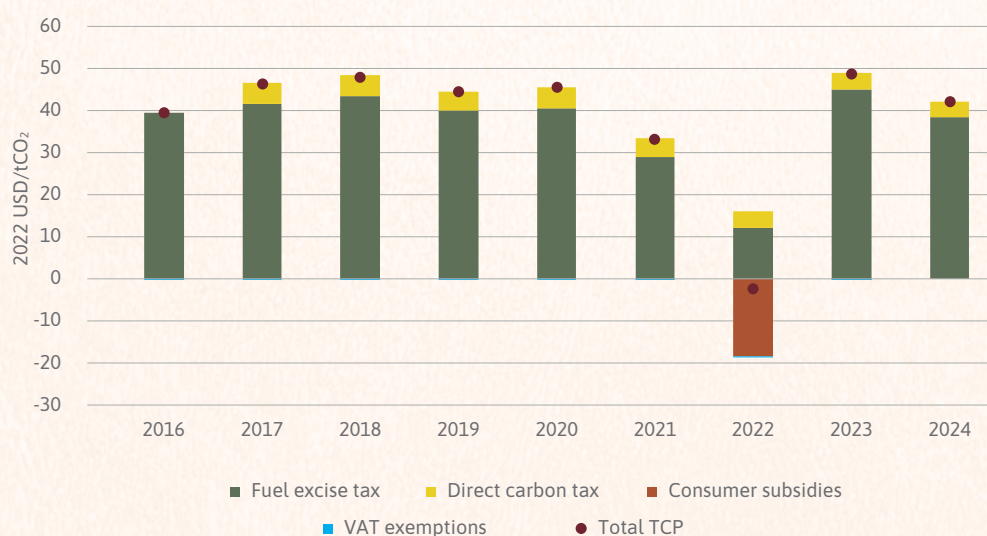
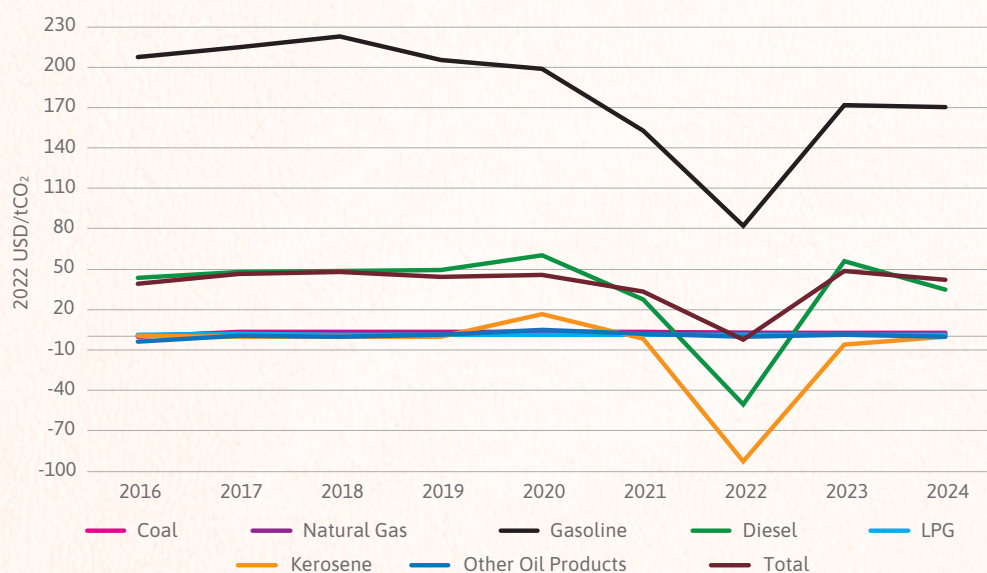
Argentina	2016	2017	2018	2019	2020	2021	2022	2023	2024	Energy emissions weight in LAC, %
Coal	5	5	4	3	2	1	1	1	1	7%
Natural Gas	-35	-30	-17	-18	-16	-28	-41	-26	-10	34%
Gasoline	152	123	119	90	98	89	64	34	66	12%
Gasoline*	199	130	116	83	104	55	-11	0	54	12%
Diesel	106	104	72	58	59	54	39	20	43	27%
Diesel*	148	110	69	52	64	24	-27	-10	33	27%
LPG	0	-21	-8	0	0	0	0	0	0	10%
Kerosene	239	242	139	62	148	75	-59	12	12	2%
Other Oil Products	0	0	-1	2	3	3	5	5	5	13%
Total	23	22	22	15	14	9	-1	-3	15	22%
Total*	38	24	20	13	16	-2	-29	-16	11	22%



34 Figures marked with an * below gasoline, diesel and total reflect the TCP estimate for the version that considers the price gap between the indicative domestic price ("barril criollo") and the WTI price.

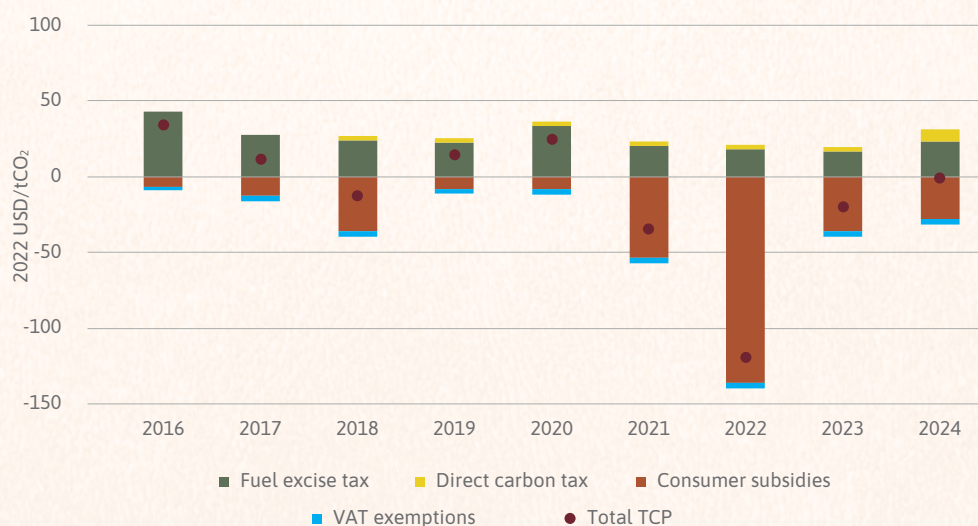
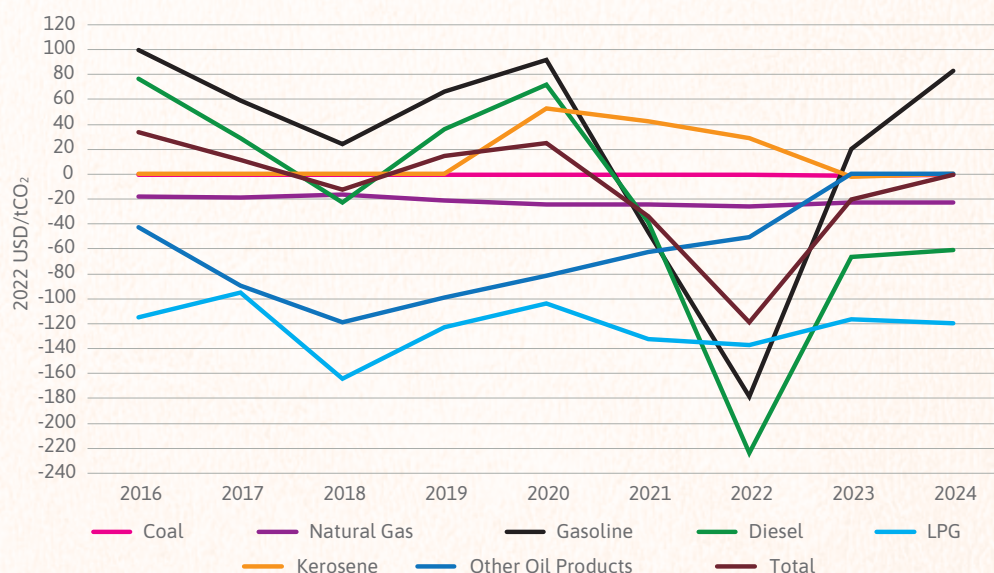
Chile TCP, 2022 US dollars per ton of CO₂

Chile	2016	2017	2018	2019	2020	2021	2022	2023	2024	Energy emissions weight in LAC, %
Coal	0	3	3	3	3	3	3	3	3	29
Natural Gas	0	3	3	3	3	3	2	2	2	5
Gasoline	208	215	223	205	199	153	82	172	170	7
Diesel	44	48	48	49	60	27	-50	56	35	19
LPG	1	2	2	1	1	1	1	1	1	10
Kerosene	0	0	0	0	16	-2	-93	-6	0	37
Other Oil Products	-4	1	0	1	5	2	0	1	0	7
Total	39	46	48	44	46	33	-2	49	42	12



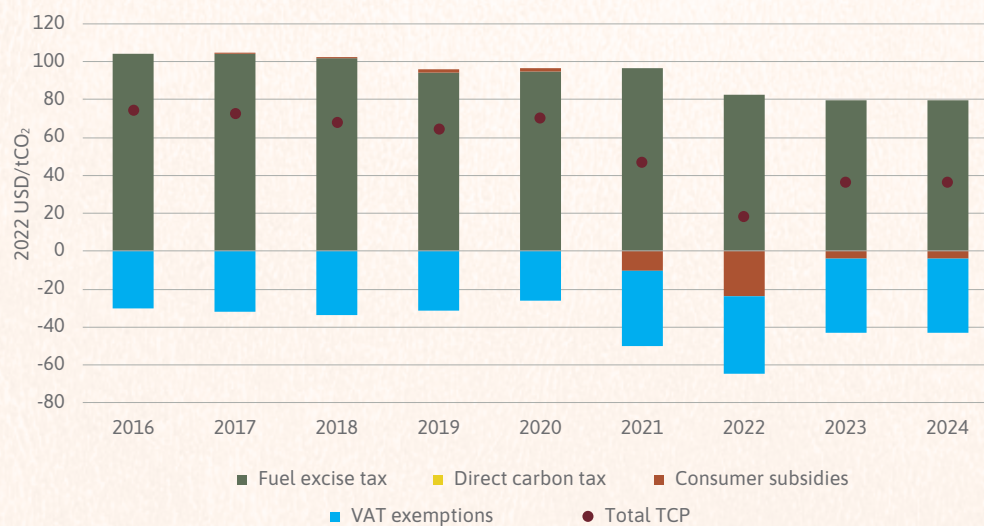
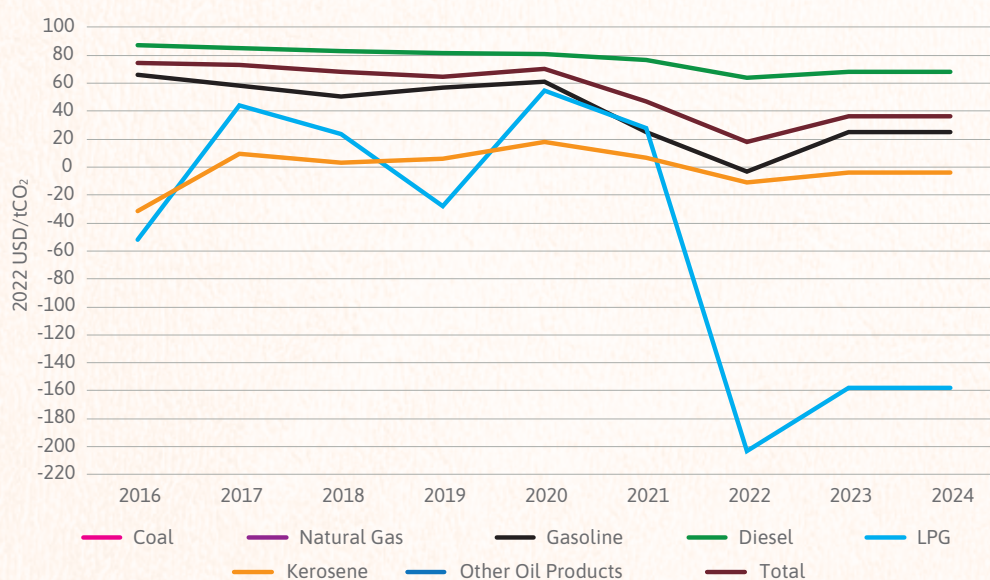
Colombia TCP, 2022 US dollars per ton of CO₂

Colombia	2016	2017	2018	2019	2020	2021	2022	2023	2024	Energy emissions weight in LAC, %
Coal	0	0	0	0	0	0	0	0	0	16
Natural Gas	-18	-18	-16	-21	-24	-24	-26	-23	-22	6
Gasoline	100	59	24	66	92	-46	-178	20	83	12
Diesel	77	29	-23	36	72	-39	-224	-67	-60	11
LPG	-115	-95	-164	-122	-104	-132	-137	-116	-119	5
Kerosene	0	0	0	0	53	43	29	-2	0	60
Other Oil Products	-43	-89	-119	-99	-82	-62	-51	0	0	7
Total	34	11	-13	15	25	-34	-119	-20	0	10



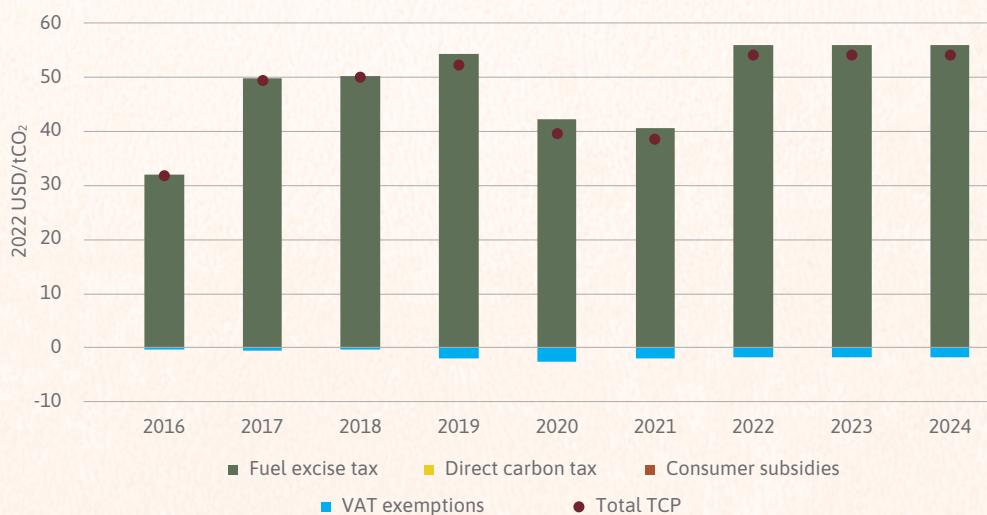
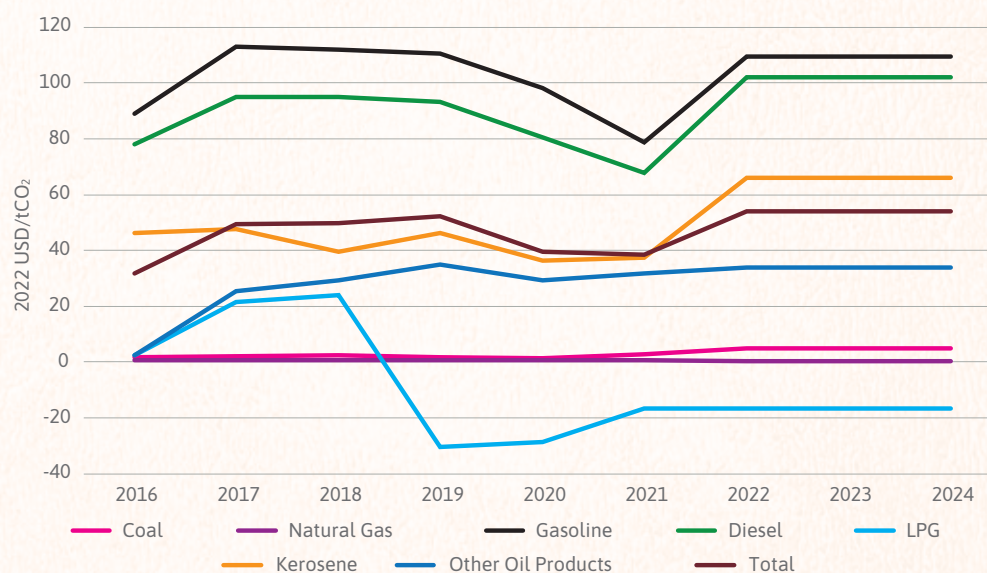
Dominica TCP, 2022 US dollars per ton of CO₂

Dominica	2016	2017	2018	2019	2020	2021	2022	2023	2024	Energy emissions weight in LAC, %
Coal										0
Natural Gas										0
Gasoline	66	59	51	57	61	25	-3	25		0
Diesel	87	85	83	82	81	77	64	68		0
LPG	-52	44	23	-28	55	28	-203	-158		0
Kerosene	-31	10	3	6	18	7	-11	-4		0
Other Oil Products										0
Total	74	73	68	64	70	47	18	37		0



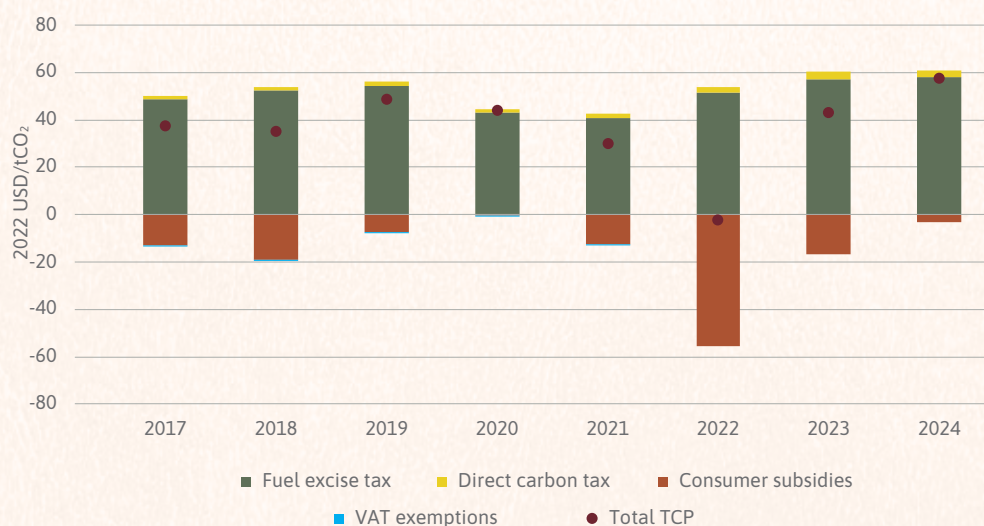
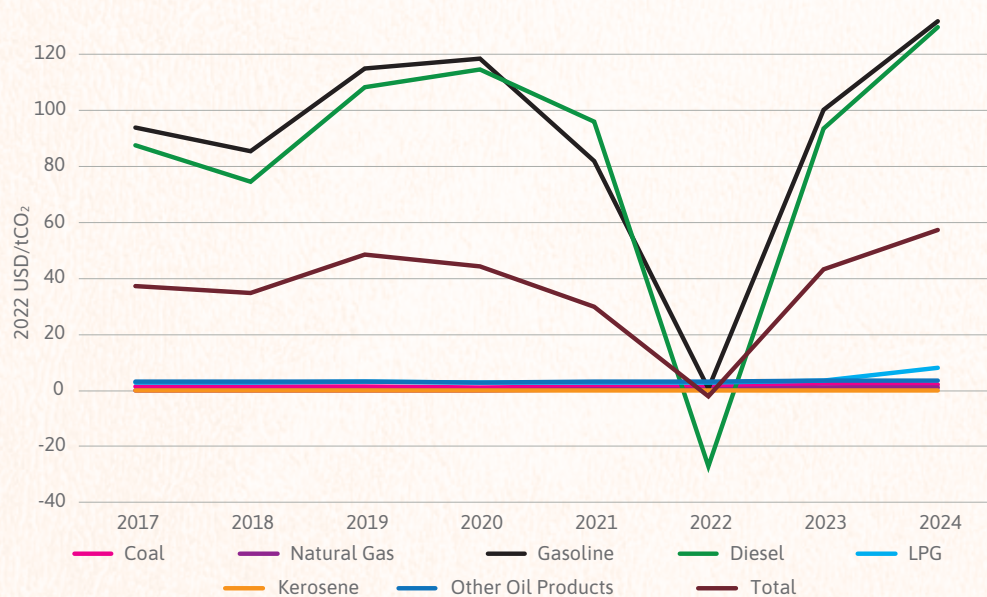
Jamaica TCP, 2022 US dollars per ton of CO₂

Jamaica	2016	2017	2018	2019	2020	2021	2022	2023	2024	Energy emissions weight in LAC, %
Coal	2	2	3	2	2	3	5			0
Natural Gas	1	1	1	1	1	1	0			1
Gasoline	89	113	112	110	98	79	109			1
Diesel	78	95	95	93	81	68	102			1
LPG	2	21	24	-30	-29	-17	-17			1
Kerosene	46	48	39	46	36	37	66			1
Other Oil Products	2	26	29	35	29	32	34			5
Total	32	49	50	52	40	39	54			1



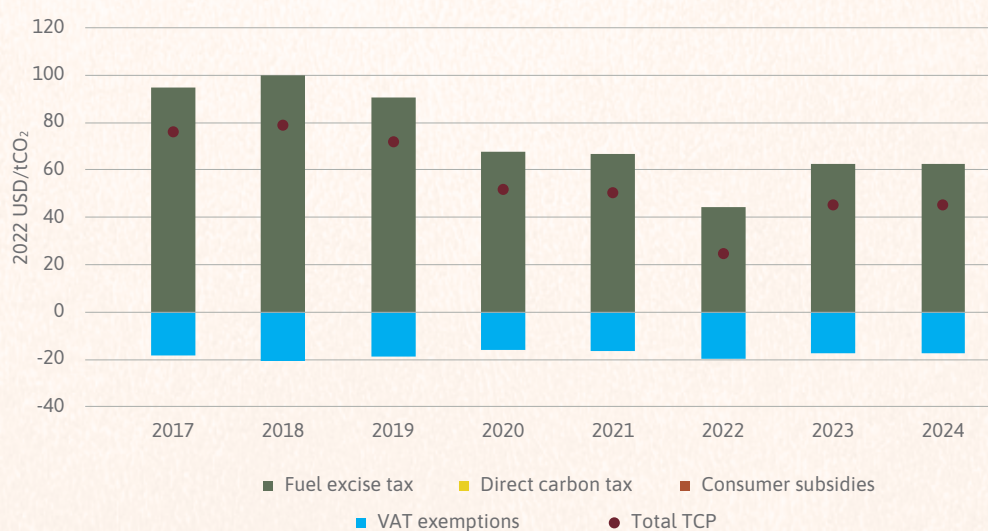
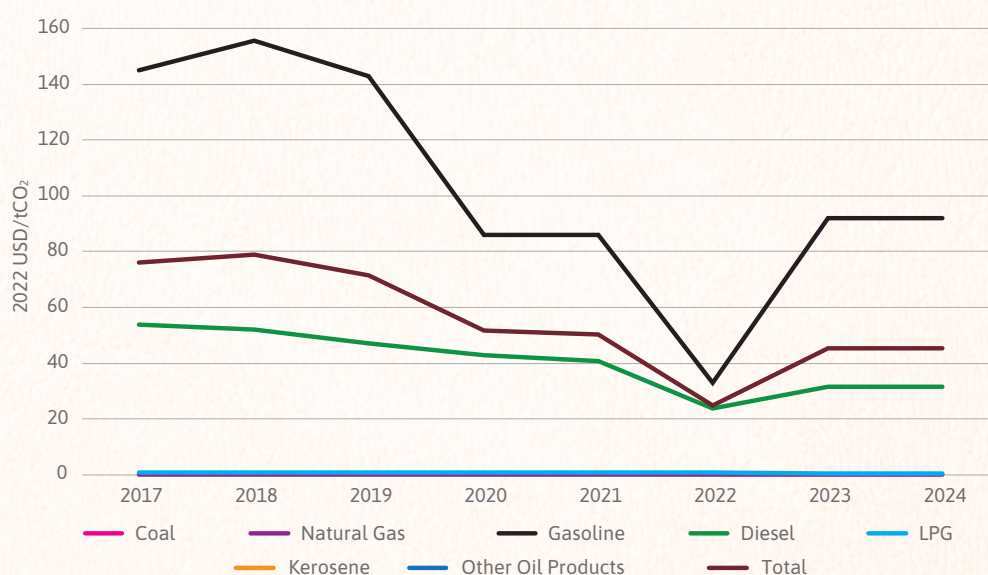
Mexico TCP, 2022 US dollars per ton of CO₂

Mexico	2016	2017	2018	2019	2020	2021	2022	2023	2024	Energy emissions weight in LAC, %
Coal		1	1	1	1	2	2	2	2	44
Natural Gas		0	0	0	0	0	1	1	1	46
Gasoline		94	85	115	118	82	1	100	132	61
Diesel		87	75	108	115	96	-27	93	130	26
LPG		3	3	3	3	3	3	4	8	61
Kerosene		0	0	0	0	0	0	0	0	0
Other Oil Products		3	3	3	3	3	3	4	4	60
Total		37	35	49	44	30	-2	43	57	47



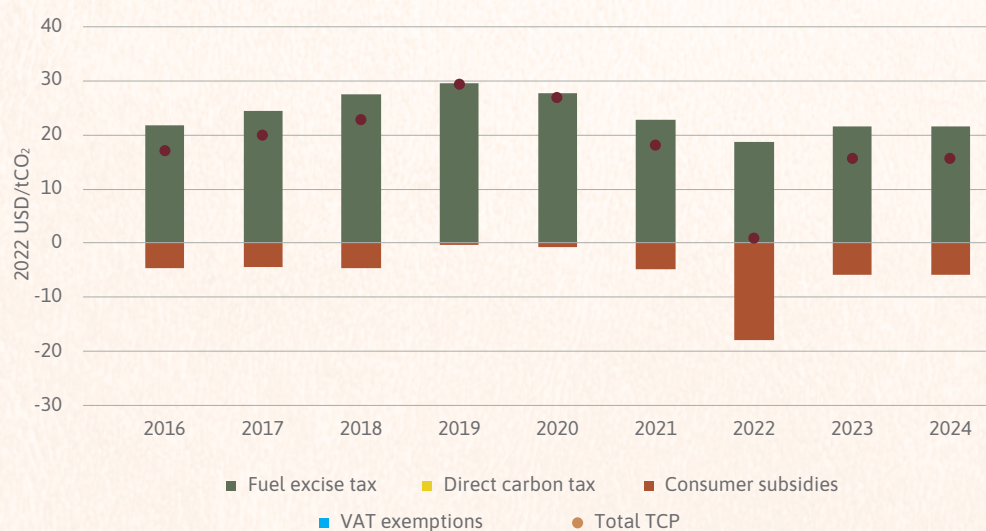
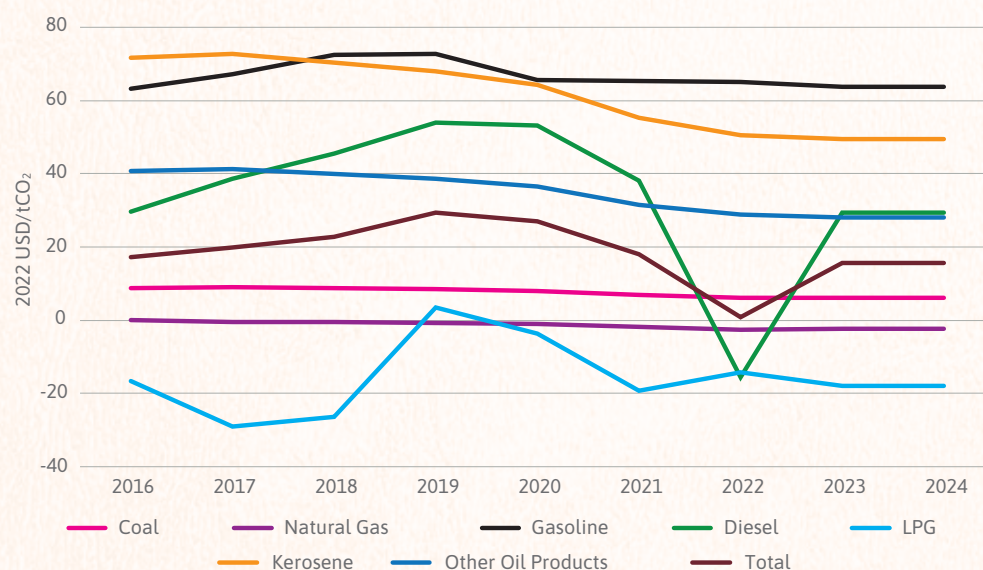
Paraguay TCP, 2022 US dollars per ton of CO₂

Paraguay	2016	2017	2018	2019	2020	2021	2022	2023	2024	Energy emissions weight in LAC, %
Coal		0	0	0	0	0	0	0		0
Natural Gas		0	0	0	0	0	0	0		0
Gasoline		145	156	143	86	86	33	92		1
Diesel		54	52	47	43	41	24	31		3
LPG		1	1	1	1	1	1	1		0
Kerosene										0
Other Oil Products										0
Total		76	79	72	52	50	25	45		1



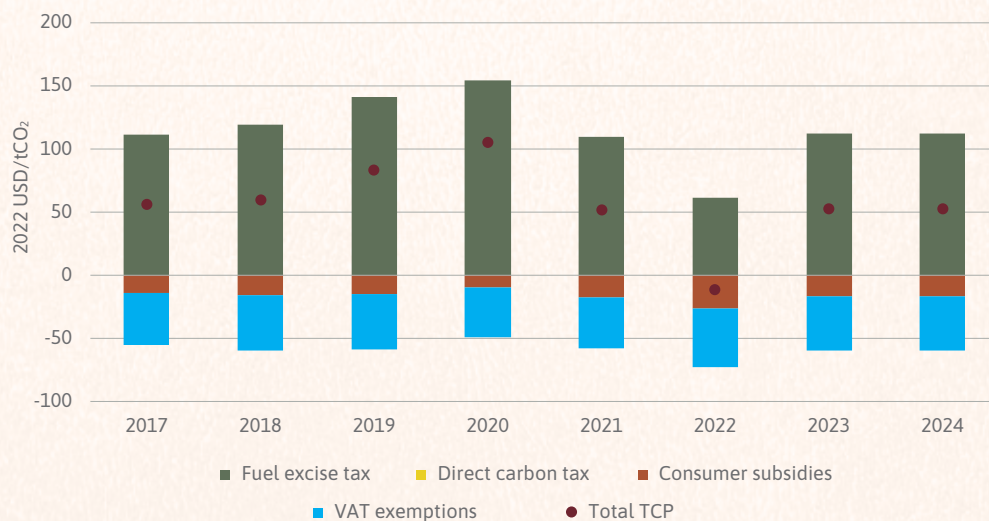
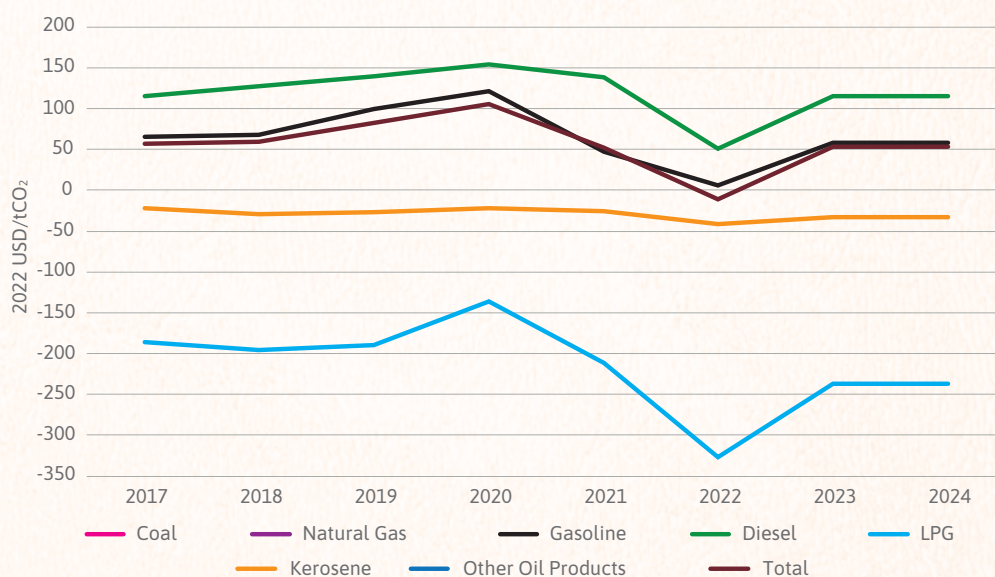
Peru TCP, 2022 US dollars per ton of CO₂

Peru	2016	2017	2018	2019	2020	2021	2022	2023	2024	Energy emissions weight in LAC, %
Coal	9	9	9	8	8	7	6	6	6	4
Natural Gas	0	0	-1	-1	-1	-2	-3	-2	-2	8
Gasoline	63	67	72	73	66	65	65	64	64	4
Diesel	30	39	45	54	53	38	-15	29	29	12
LPG	-16	-29	-26	3	-4	-19	-14	-18	-18	12
Kerosene	72	73	70	68	64	55	51	49	49	0
Other Oil Products	41	41	40	39	36	31	29	28	28	5
Total	17	20	23	29	27	18	1	16	16	8



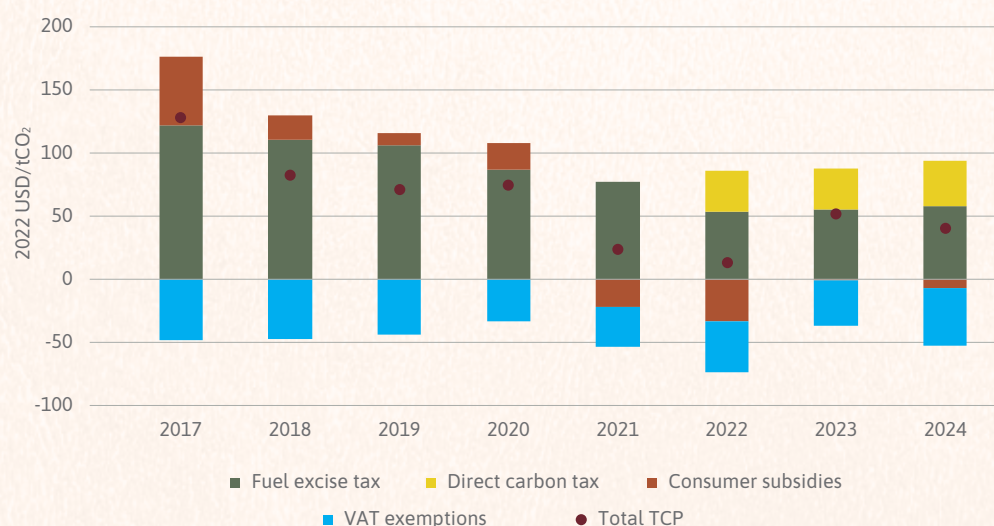
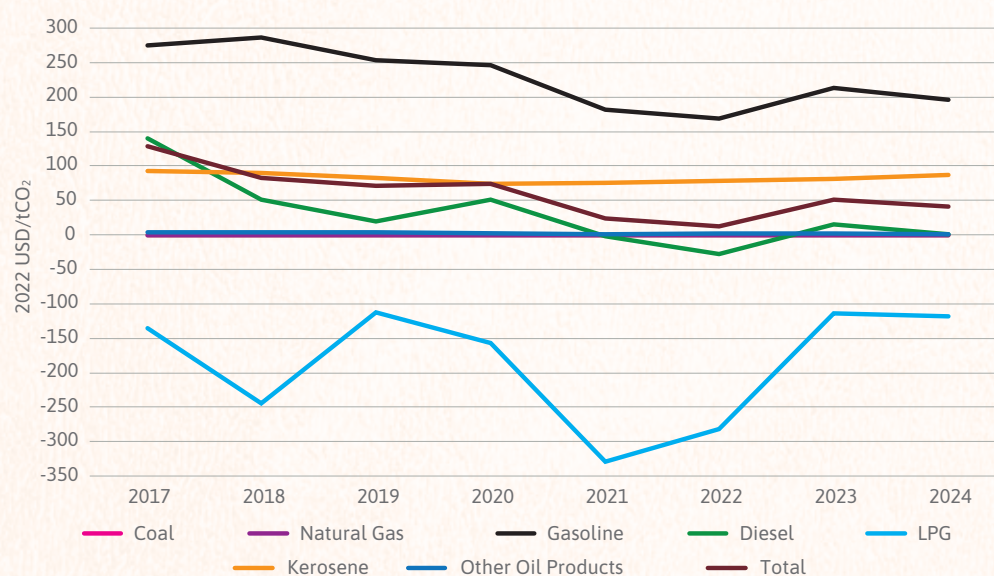
St. Lucia TCP, 2022 US dollars per ton of CO₂

St.Lucia	2016	2017	2018	2019	2020	2021	2022	2023	2024	Energy emissions weight in LAC, %
Coal										0
Natural Gas										0
Gasoline		65	68	100	121	47	6	58		0
Diesel		115	127	139	154	138	50	115		0
LPG		-186	-196	-190	-136	-212	-327	-237		0
Kerosene		-22	-29	-26	-22	-26	-42	-32		0
Other Oil Products										0
Total		57	60	83	105	52	-11	53		0



Uruguay TCP, 2022 US dollars per ton of CO₂

Uruguay	2016	2017	2018	2019	2020	2021	2022	2023	2024	Energy emissions weight in LAC, %
Coal		0	0	0	0	0	0	0	0	0
Natural Gas		0	0	0	0	0	0	0	0	0
Gasoline		276	287	253	246	182	170	214	196	1
Diesel		140	51	20	52	-1	-28	15	1	2
LPG		-136	-244	-112	-157	-329	-282	-113	-119	1
Kerosene		92	90	83	74	76	79	81	87	0
Other Oil Products		4	4	4	3	1	1	1	1	2
Total		128	83	71	75	24	13	51	41	1



Annex B.

A model of the energy transition and carbon prices

For the analysis of the green transition in LAC, the carbon-constrained (general equilibrium) growth model of Burda, Göth, and Zessner-Spitzenberg (2025) is employed. The model is characterized by deterministic, unbalanced growth driven by exogenous technical progress. production side of the model economy consists of four sectors. One sector combines intermediate inputs into a final output good and three sectors produce the intermediate input goods: dirty energy, clean energy, and non-energy inputs. Both energy sectors use capital intensive technologies. In the production of final output, clean and dirty energy are perfect substitutes, but both are strong complements to non-energy inputs. Each intermediate goods sector uses a separate constant-returns-to-scale production technology defined by its total factor productivity and output elasticities with respect to the two primary production factors, capital and labor. Both energy sectors use capital intensive technologies. Non-energy input goods, which represent a broad spectrum of economic activities, are labor intensive in production. This stylized sectoral structure provides a simplified representation of an economy with intricate sectoral input-output linkages. Since dirty energy technology emits greenhouse gases in production, a cumulative emissions budget necessitates a phase-out of dirty energy production in the medium run.

While the long run elasticity of substitution between low emission and emission intensive energy inputs is infinite, emission intensive energy capital stock advantages, combined with sector-specific capital adjustment costs, limit their effective short run substitutability. These costs reflect the practical constraints in transitioning capital stocks, such as the availability of specialized labor, suitable capital, and the requisite intermediate production lines. Additionally, the quicker the switch from the emission intensive energy capital stock to the low emission energy capital stock occurs, the higher the capital adjustment costs.

The model is calibrated to a typical Latin-American economy, using empirical observations from Peru in the years 2019/20 to identify its parameters, following the strategy of Göth, Zessner-Spitzenberg, and Fischer (2025). Based on Göth, Zessner-Spitzenberg, and Fischer (2025) it is assumed that initially, dirty energy technology is 40 percent more productive than its clean counterpart. Over time, clean technology is projected to catch up and to reach cost parity by 2050. The model's general equilibrium growth path is computed from optimal choices of private households and firms subject to a tax on emissions set by a policymaker. The policymaker faces the challenge of achieving an efficient transition to clean energy while respecting the emissions budget.

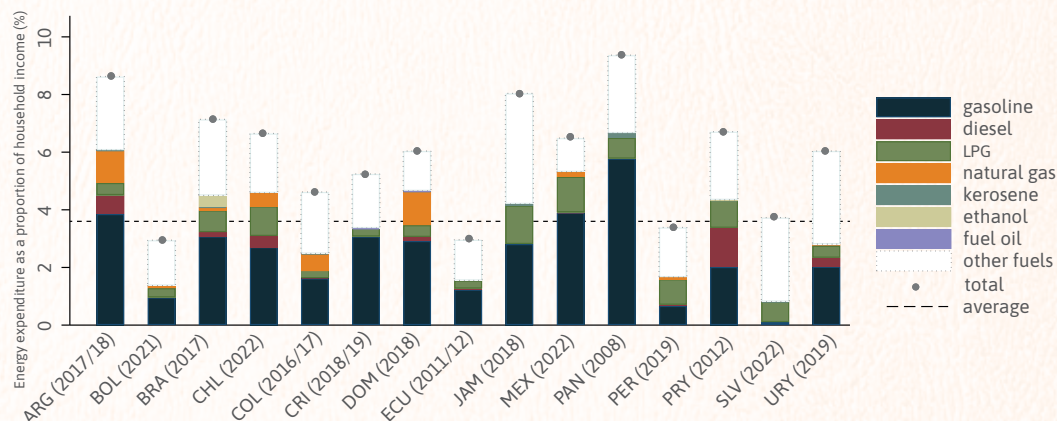
Annex C: Additional tables and figures for welfare and distributional analysis

Table C1 List of countries, data sources, and social assistance programs considered

Country Code	Country Name	Household Survey	Survey Year	Main Social Assistance Programs
ARG	Argentina	National Household Expenditure Survey (ENGHo)	2017/18	Asignación Universal por Hijo ^a
BOL	Bolivia	National Household Survey (EH)	2021	Bono Juana Azurduy Bono Juancito Pinto Renta Dignidad
BRA	Brazil	Consumer Expenditure Survey (POF)	2017	Bolsa Familia (Auxilio Brasil)
CHL	Chile	Household Budget Survey (EPF)	2022	Asignación Familiar Subsidio Único Familiar Seguridades y Oportunidades
COL	Colombia	National Household Budget Survey (ENPH)	2016/17	Más familias en acción
CRI	Costa Rica	National Household Income and Expenditure Survey (ENIGH)	2018/19	Avancemos Régimen no contributivo de pensiones
DOM	Dominican Republic	National Household Expenditure and Income Survey (ENGIH)	2018	Comer es primero
ECU	Ecuador	National Survey of Household Income and Expenditure (ENHIGUR)	2011/12	Bono de Desarrollo Humano
JAM	Jamaica	Jamaica Survey of Living Conditions (JSLC)	2018	Programme of Advancement Through Health and Education
MEX	Mexico	National Survey of Household Income and Expenditure (ENIGH)	2022	Beca Benito Juárez Básica y Benito Juárez Media Superior
PAN	Panama	Living Standards Survey (ENV)	2008	Red de Oportunidades SENAPAN 120 a los 65 Angel Guardian
PER	Peru	National Household Survey (ENAHU)	2019	Juntos Pension 65
PRY	Paraguay	Income, Expenditure Survey and Living Conditions (EIGyCV)	2012	Tekopora Adultos Mayores
SLV	El Salvador	Multipurpose Household Survey (EHPM)	2022	Comunidades Solidarias
URY	Uruguay	National Household Expenditure and Income Survey (ENGIH)	2016	Tarjeta Uruguay Social Asignaciones Familiares del Plan Equidad

a. In the case of the Asignación Universal por Hijo, eligibility is approximated through the demographic and employment criteria of the program as the household survey does not identify beneficiaries.

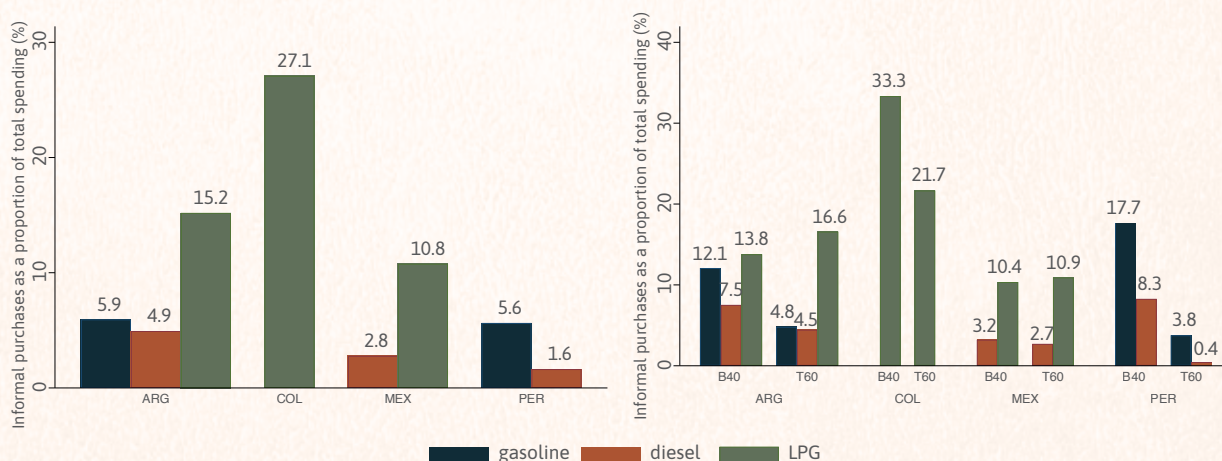
Figure C1. Energy expenditure relative to household income, by country



Source: Authors' calculations based on nationally representative household expenditure surveys (refer to annex C, table C1 for further details).

Note: In El Salvador, gasoline expenditure is only reported for work-related activities. The dotted line shows the average share of fuel expenditure over household income across countries, which includes expenditure in gasoline, diesel, LPG, natural gas, kerosene, ethanol, and fuel oil. The category "other fuels" includes the fuels not listed in the legend of the figure, which in most cases refers to electricity.

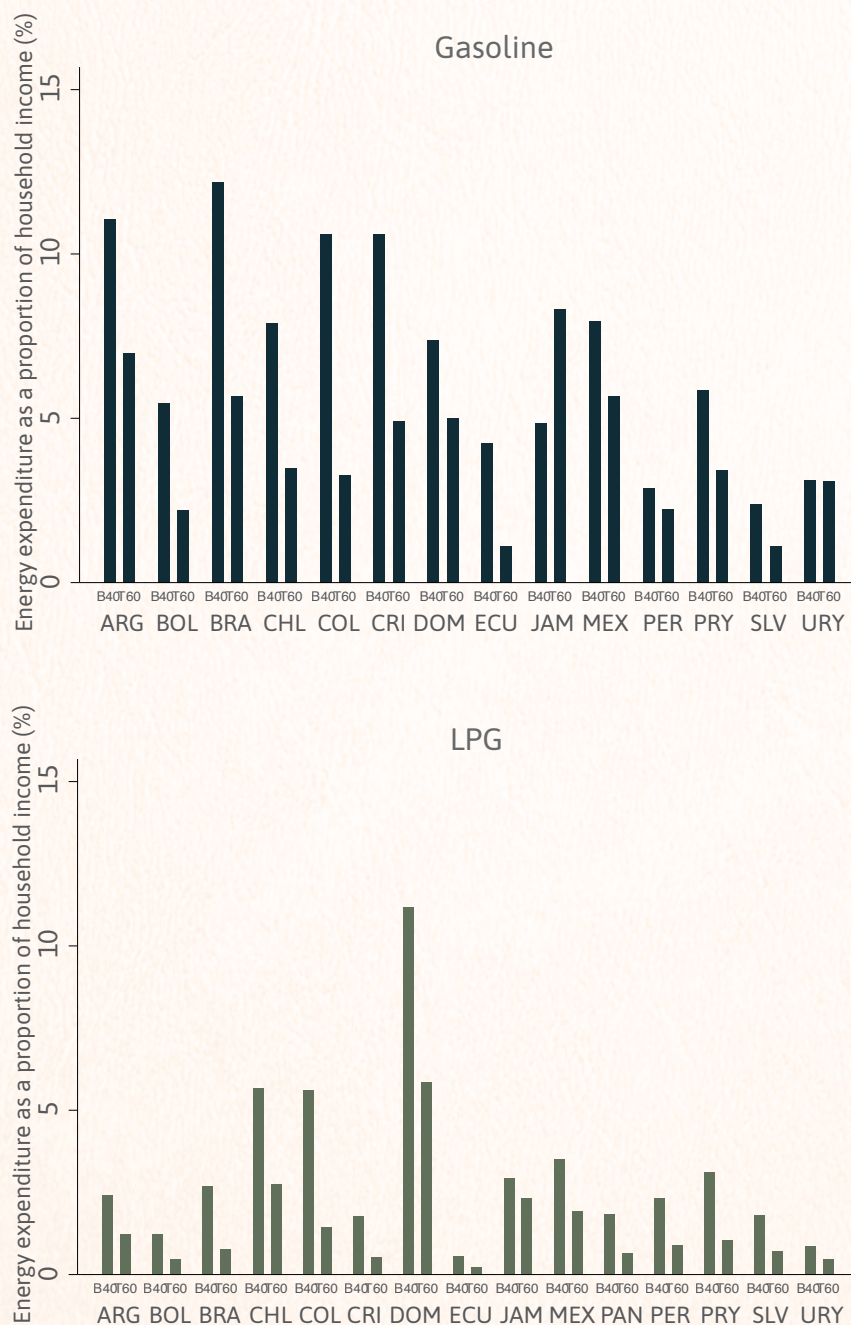
Figure C2. Proportion of informal spending over total fuel spending, by fuel type, income group, and country



Source: Authors' calculations based on nationally representative household expenditure surveys (refer to annex C, table C1 for further details).

Note: The definition of informal purchases is based on the place of purchase and payment method employed, and varies by country. Statistics are presented separately for households classified in the bottom 40 percent of the per capita income distribution (B40) and those in the top 60 percent (T60).

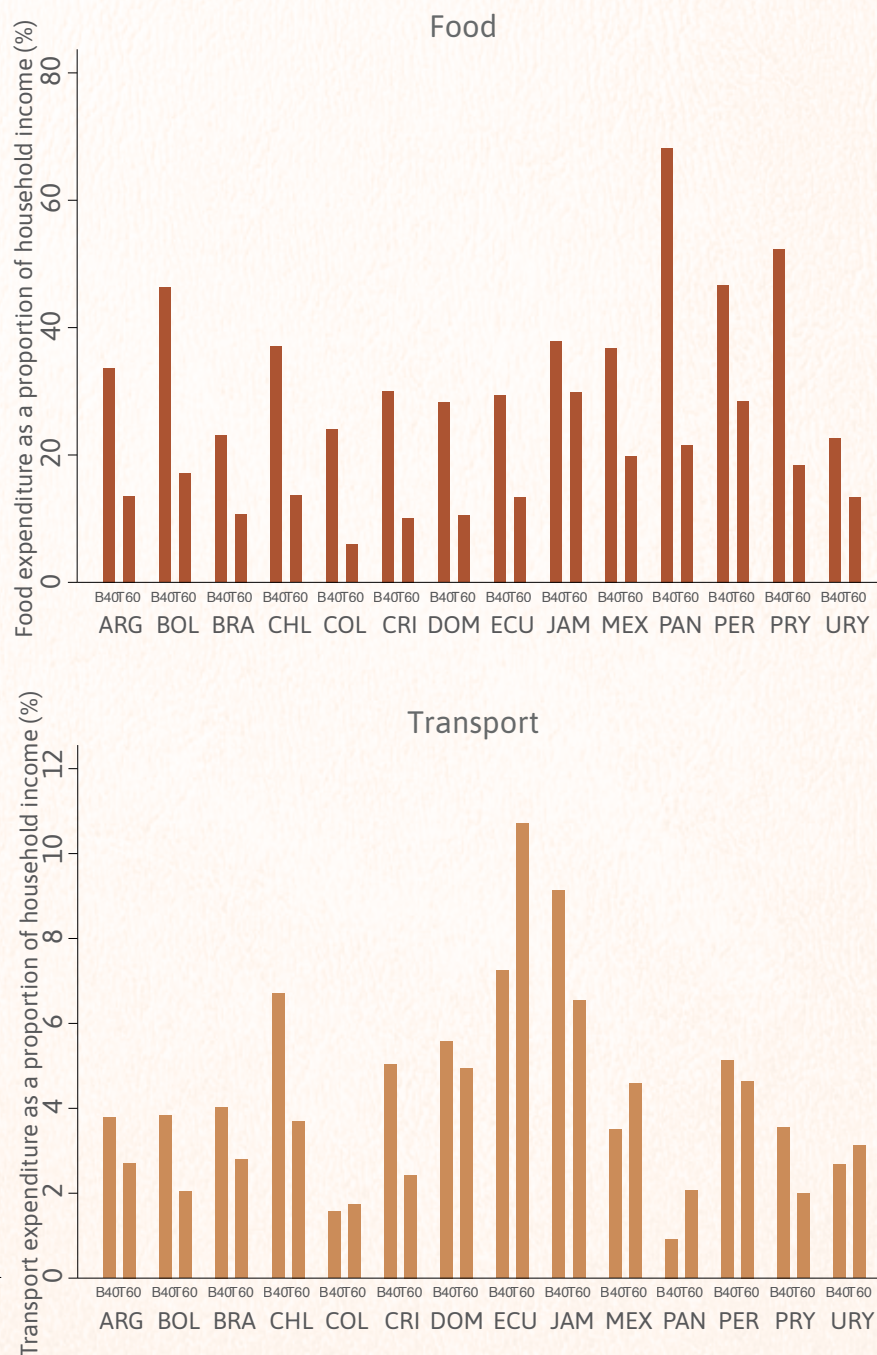
Figure C3. Gasoline and LPG expenditure relative to household income conditional on households reporting positive fuel expenditure, by income group and country



Source: Authors' calculations based on nationally representative household expenditure surveys (refer to annex C, table C1 for further details).

Note: The statistics shown in this figure are calculated for the subset of households that report positive expenditures in each fuel. Note that in the case of gasoline expenditures, Panama is not included in the figure because of the limited number of observations at the bottom of the distribution, which affects the quality of the estimates. Statistics are presented separately for households classified in the bottom 40 percent of the per capita income distribution (B40) and those in the top 60 percent (T60).

Figure C4. Share of food and transport expenditures over household income, by income group



Source: Authors' calculations based on nationally representative household expenditure surveys (refer to annex C, table C1 for further details).

Note: Statistics are presented separately for households classified in the bottom 40 percent of the per capita income distribution (B40) and those in the top 60 percent (T60). Transport expenditures do not include energy expenditures considered in figure 21 and figure C1. In the case of El Salvador, the household survey does not contain information on food and transport expenditures.

Table C2. Details on the country specific microsimulations tools

Country (baseline year)	Survey data used	Was survey-to-survey imputation needed? (method used)	List of direct taxes/contributions and direct transfers included in the tool	List of indirect taxes and subsidies included in the tool	IO table used to model indirect price effects (source, year, assumptions made, sector identified as “fuels”)	Additional notes (in case Commitment to Equity was not used, explain the methodology)
Brazil (2017)	2017/2018 Pesquisa de Orçamentos Familiares (POF). For this analysis, the following household fuel expenditures could be identified: gasoline, diesel, LPG, ethanol, natural gas, and kerosene	No	Direct transfers: • Bolsa Familia	Indirect taxes: • Program of Social Integration (PIS)/ Contribution for the Financing of Social Security (COFINS) • Tax on the movement of goods and services (Imposto sobre Circulação de Mercadorias e Serviços) • Tax on the importation of technical services and royalties (CIDE) Combustíveis	An input-output table was constructed based on the 2015 Supply-Use Tables published by Brazil's NSO. It was necessary to break down the petroleum industry into three separate components: production of diesel, gasoline, and rest of petroleum refinery. The supply side of the SUT was estimated by allocating the corresponding output (primary and secondary if needed) to the new industries while keeping the original totals. The value of intermediate consumption by product for the new industries was derived by: (i) obtaining additional information on the input structure for these industries; and (ii) rebalancing the SUT to ensure that GDP is not affected by these calculations. Annual reports from companies like Petrobras Gas were also utilized to obtain a more accurate IOT structure for the petroleum industry	The PNAD-C dataset used for the Commitment to Equity does not have information on consumption, so the Commitment to Equity was not used. We use monetary income reported in the POF for the disposable income variable, and subtract consumption taxes to estimates consumable income

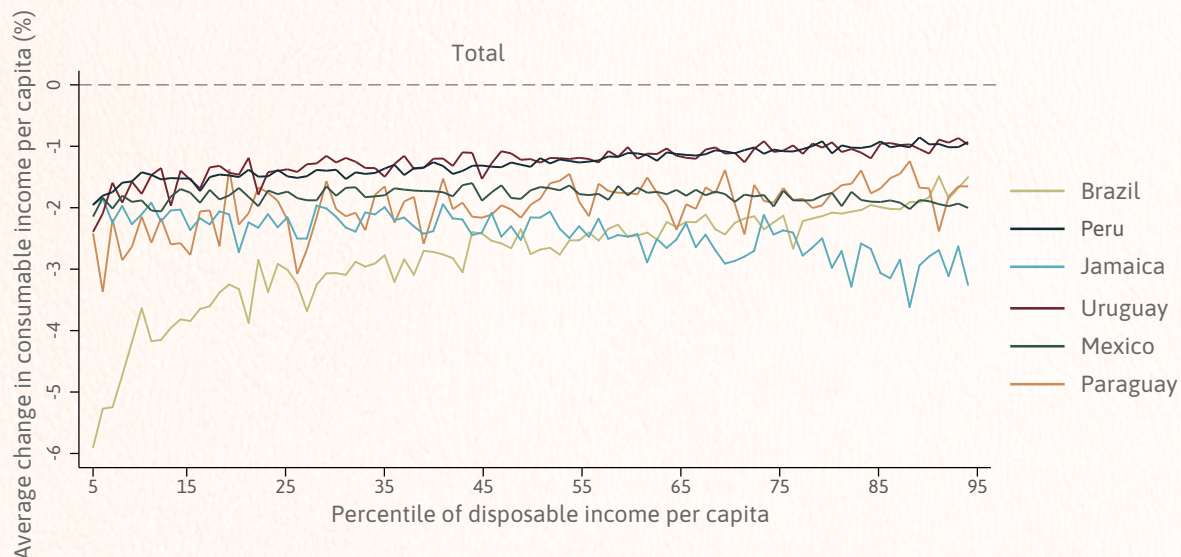
Jamaica (2018)	2018 Jamaica Survey of Living Conditions (JSLC)		Social contributions: • Pension contributions All direct taxes: • Income tax • Education tax • Property tax • Contributions to social security (National Insurance Scheme) Contributory pensions: • Public pensions • Private pensions Direct transfers and non-contributory pensions: • Programme of Advancement Through Health and Education • Poor Relief • School Feeding Programme • Jamaica Drug for the Elderly Programme	Indirect taxes: • VAT • Excise tax (gasoline, kerosene) • Carbon tax		
Mexico (2022)	2022 Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH)	No	Direct taxes and social security contributions: • Income Taxes • Regimen de Actividad Empresarial • Regimen Simplificado de Confianza • Personal deductions Direct Transfers: • Benito Juarez Basica • Benito Juarez Media Superior • Escribiendo Futuro • Construyendo Futuro • Pensión Adultos Mayores • Bienestar Discapacidad • Madres Trabajadoras • Producción para el Bienestar • Fertilizantes para el bienestar • Precios de Garantía	Indirect Taxes: • VAT (Impuesto al Valor Agregado) • Excise (Impuesto Especial sobre Producción y Servicios) • Carbon tax	The matrix used was published by the National Institute of Statistics and Geography (INEGI), 2013. The matrix is 262x262. Fuels were identified using the following category: sector 66 "Fabricación de productos derivados del petróleo y carbón"	MexSim (Mexico Simulation Tool for Mexico)

Paraguay (2021)	2021 Encuesta Permanente de Hogares Continua EPHC (from INE) 2011/12 Encuesta de Ingresos y Gastos y Condiciones de Vida (from INE). For this analysis, the following household fuel expenditures could be identified: gasoline, diesel, flex, LPG, and kerosene.	Yes (Dmatch approach)	Direct taxes and contributions: • Income tax (Impuesto a las Rentas Personal) • Rentas de trabajo • Rentas de capital • Impuesto a las Rentas Empresarial • Simple y Resimple • Impuestos a los Dividendos y Utilidades • Contribuciones a la seguridad social Direct transfers: • Tekopora • Adulto Mayor • Becas educativas • Secundaria • Terciaria • Transferencia de viveres • Útiles Escolares • Alimentación escolar	Indirect taxes: • VAT (Impuesto al Valor Agregado) • Excise (Impuesto Selectivo al Consumo) Subsidies: • Electricity • Public transport • Housing	An input-output table was constructed based on the 2014 Supply-Use Tables published by Paraguay's Central Bank. For the fuel tax welfare and distributive analysis, gasoline and diesel were identified in the table using the following categories: Gasolina, Diesel and GLP.	Commitment to Equity
Peru (2019)	2019 Encuesta Nacional de Hogares (ENAH). The survey includes both income and expenditure data	No	Direct taxes and contributions: • Tax income • Rentas de trabajo • Rentas de capital • Impuesto a la propiedad • Contribuciones a la seguridad social Direct transfers: • JUNTOS • Pension65 • Beca18 • Bonogas • Pensión por viudez, orfandad o sobrevivencia • Donaciones de bienes • Non-monetary programs (Wawasi-cuidado de menores, Centro de Emergencia Mujer, Pronama, Jóvenes productivos, Trabaja Perú, Impulsa Perú)	Indirect taxes: • VTA (Impuesto General a las Ventas) • Excise (Impuesto Selectivo al Consumo)	An input-output table was constructed based on the 2019 Supply-Use Tables published by INEI. The analysis includes the following categories: gasoline, natural gas, LPG, and diesel. Each fuel had a unique sector in the input-output table.	Commitment to Equity

Uruguay (2021)	2021 Encuesta Continua de Hogares 2016/17 Encuesta de Gastos e Ingresos de los Hogares (ENGIH). For this analysis, the following household fuel expenditures could be identified: gasoline, diesel, LPG, natural gas, and kerosene	Yes (Dmatch approach)	Direct taxes and contributions: • Income tax (Impuesto a las Rentas de las Personas Físicas) • Rentas de trabajo • Rentas de capital • Impuesto a las Rentas del Agro • Fondo de Reconversión Laboral • Fondo de Solidaridad • Contribuciones de salud • Impuesto de Asistencia a la Seguridad Social Direct transfers: • Pensión por vejez e invalidez • Plan de Equidad • Tarjeta Uruguay Social • Canastas • Comidas en comedores sociales • Asignaciones Familiares • Contributivas • Seguro de desempleo • Compensaciones por accidente, maternidad o enfermedad • Hogar Constituido	Indirect taxes: • VTA (Impuesto al Valor Agregado) • Impuesto Específico Interno • Tax to CO2 emissions	An input-output table was constructed based on the 2016 Supply-Use Tables published by Uruguay's Central Bank. For the fuel tax welfare and distributive analysis, gasoline and diesel were identified in the table using the following categories: Gasolina para motores de vehículos de transporte terrestre, Combustibles para calderas (fuel oil y diesel oil).	Commitment to Equity
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Source: World Bank calculations.

Figure C5. Estimated short-term income effect of a 25 percent price increase in all fuels, by country



Source: Authors' calculations based on country specific microsimulations.

Note: This figure shows the estimated percentage change in per capita consumable income between the baseline and a 25 percent increase in the price of all fuels for each country. The type of fuels considered in each country are those shown in figure 22. Results are presented as the average across households for each percentile of the per capita disposable income distribution. Individuals in the bottom and top 5 percent of the disposable income distribution are excluded due to large variation in the data.

Table C3. Contribution to additional fuel tax collection, by income quintile and country

Country	Income quintile	25 percent tax-induced fuel price shock						
		Gasoline	Diesel	LPG	Kerosene	Natural gas	Ethanol	All fuels
BRA	Q1	4.6	7.7	15.4	-	-	4.8	6.7
	Q2	9.2	12.3	19.6	-	-	9.0	11.2
	Q3	14.2	16.8	21.2	-	-	14.1	15.7
	Q4	22.3	22.5	23.4	-	-	22.7	22.6
	Q5	49.7	40.6	20.5	-	-	49.5	43.9
JAM	Q1	0.4	7.6	8.3	22.7	-	-	5.8
	Q2	2.0	12.3	14.1	16.2	-	-	9.8
	Q3	6.3	16.3	17.2	21.0	-	-	13.7
	Q4	19.0	21.8	24.4	17.0	-	-	21.4
	Q5	72.3	42.1	36.1	23.1	-	-	49.3

MEX	Q1	4.5	8.9	9.7	-	3.1	-	6.0
	Q2	8.0	12.2	14.8	-	5.9	-	9.9
	Q3	12.2	15.3	18.4	-	13.1	-	14.0
	Q4	20.5	20.7	22.5	-	22.5	-	21.1
	Q5	54.8	42.9	34.6	-	55.3	-	49.1
PER	Q1	4.6	6.7	10.8	-	9.5	-	7.5
	Q2	8.5	12.3	16.5	-	14.8	-	12.7
	Q3	12.6	17.7	20.1	-	19.2	-	17.2
	Q4	17.9	23.7	22.6	-	23.6	-	22.0
	Q5	56.4	39.7	30.0	-	33.0	-	40.6
PRY	Q1	9.1	8.7	5.5	-	-	-	8.4
	Q2	12.9	10.7	11.8	-	-	-	11.8
	Q3	16.2	12.5	21.6	-	-	-	15.7
	Q4	24.4	21.1	26.2	-	-	-	23.4
	Q5	37.4	47.0	34.9	-	-	-	40.7
URY	Q1	7.3	10.2	14.8	14.6	0.2	-	9.2
	Q2	10.3	13.3	17.2	18.0	2.7	-	12.2
	Q3	14.9	17.3	19.7	23.5	0.4	-	16.3
	Q4	20.9	23.0	23.0	14.6	6.2	-	21.7
	Q5	46.5	36.3	25.3	29.3	90.6	-	40.6

Source: Authors' calculations based on country specific microsimulations.

Note: This table shows how households in each quintile of the per capita disposable income distribution contribute to the increased tax collection between the baseline and the 25 percent price increase scenarios for each country and fuel.

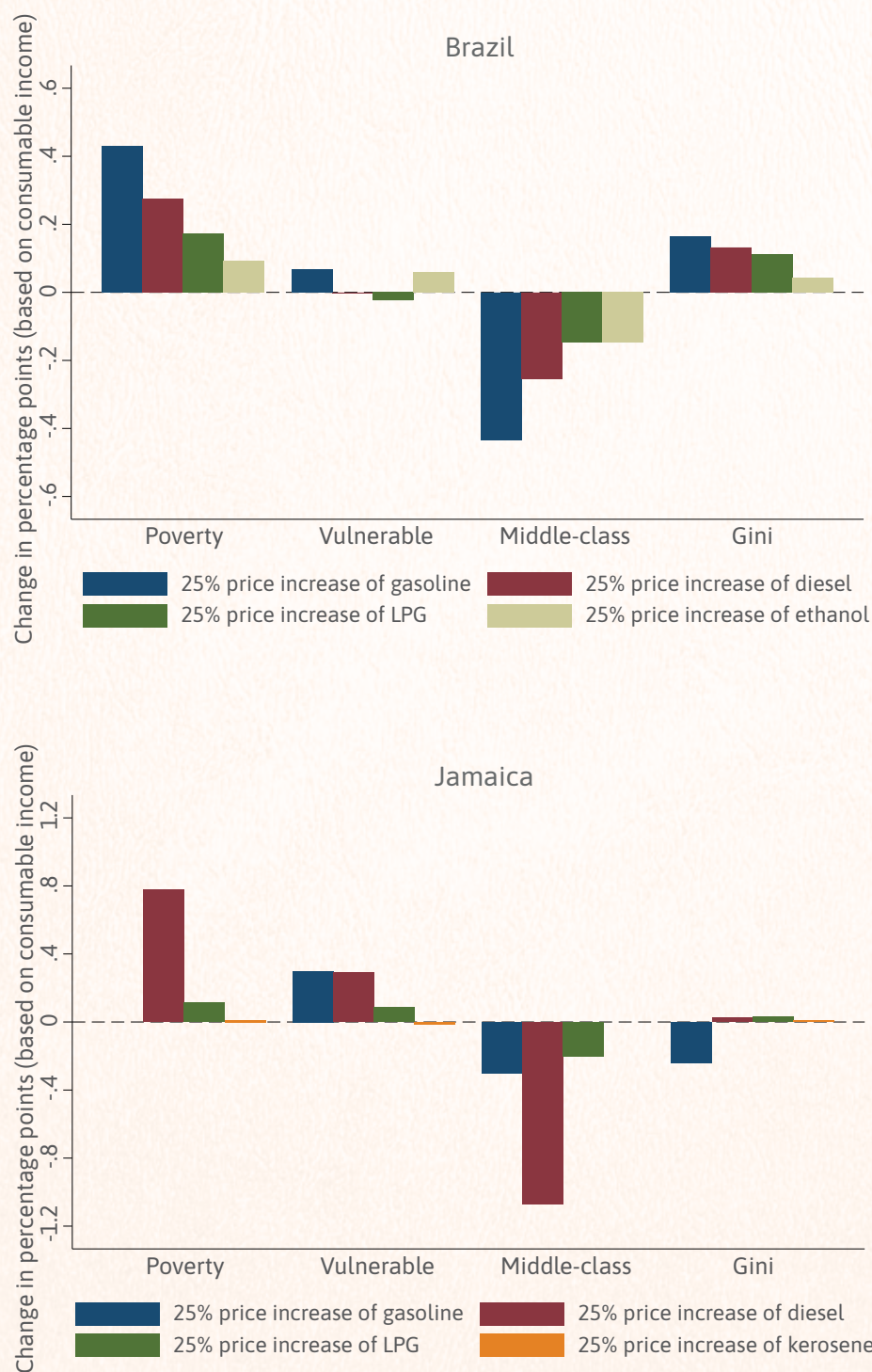
Table C4. Progressivity of a 25 percent fuel-specific price increase (Kakwani coefficient), by fuel type and country

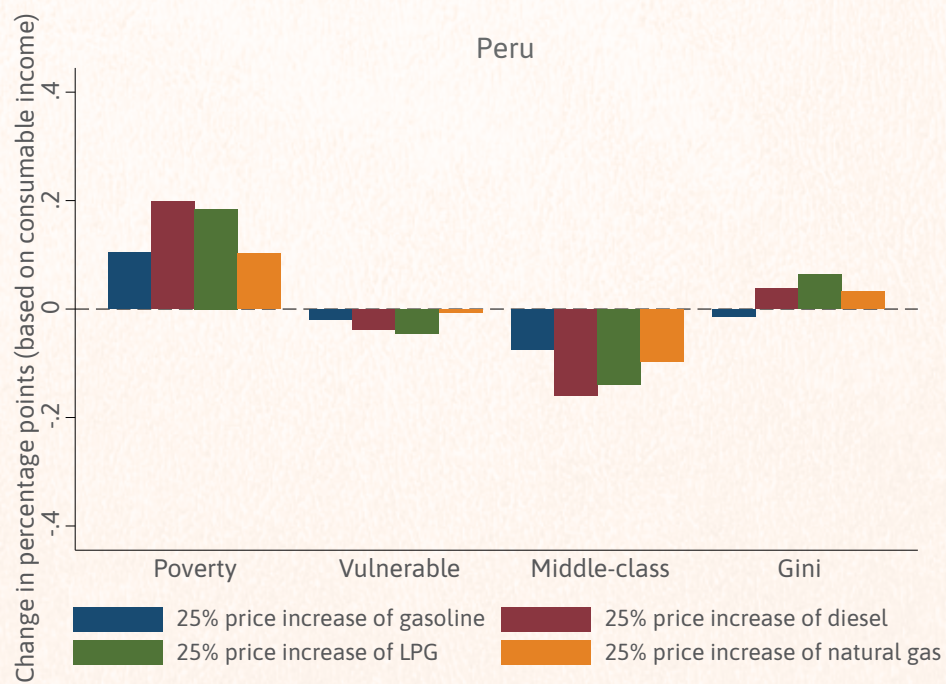
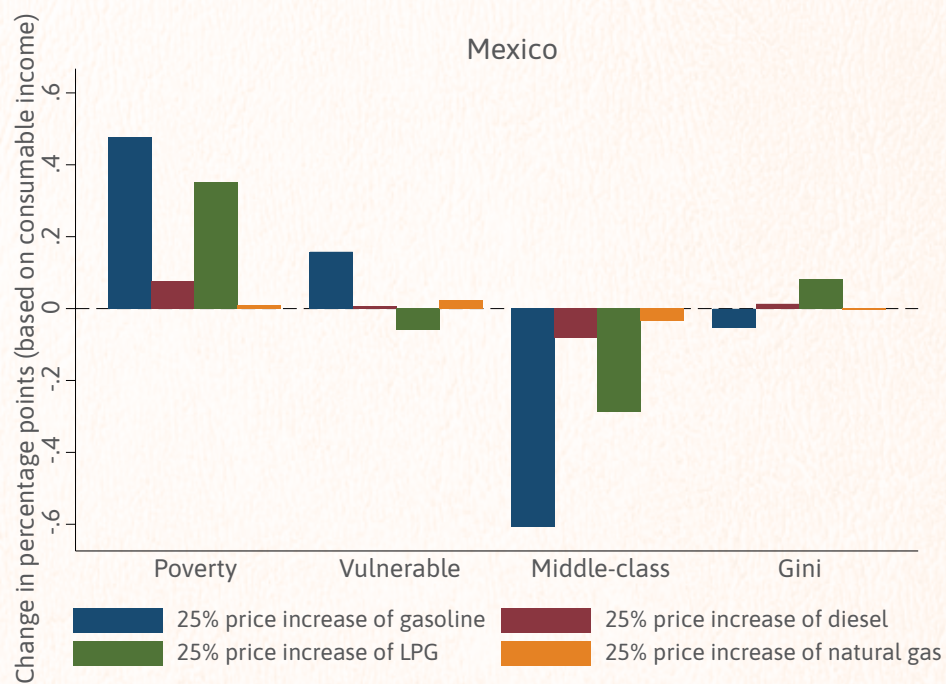
Country	25 percent tax-induced fuel price shock					
	Gasoline	Diesel	LPG	Kerosene	Natural gas	Ethanol
BRA	-0.09	-0.21	-0.48	-	-	-0.09
JAM	0.34	-0.02	-0.08	-0.34	-	-
MEX	0.06	-0.09	-0.18	-	0.16	-
PER	-0.07	-0.10	-0.23	-	-0.14	-
PRY	-0.14	-0.05	-0.13	-	-	-
URY	-0.02	-0.14	-0.29	-0.26	0.45	-

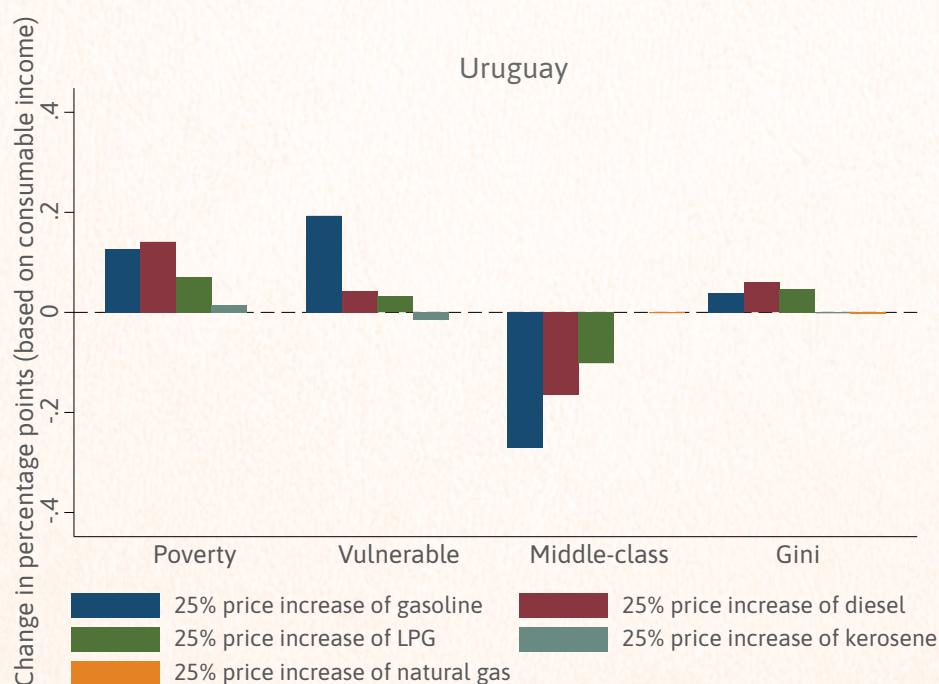
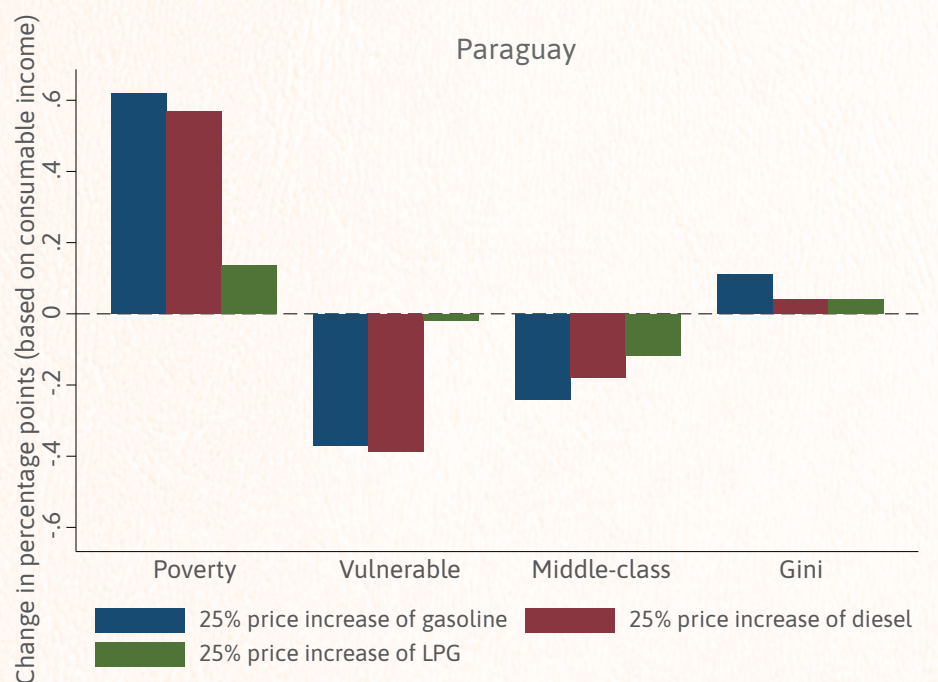
Source: Authors' calculations based on country specific microsimulations.

Note: This table shows the Kakwani coefficient associated with a tax-induced increase in the retail price of each fossil fuel separately.

Figure C6. Estimated changes in inequality, poverty, vulnerability and middle-class with respect to the baseline scenario, by country and fuel type



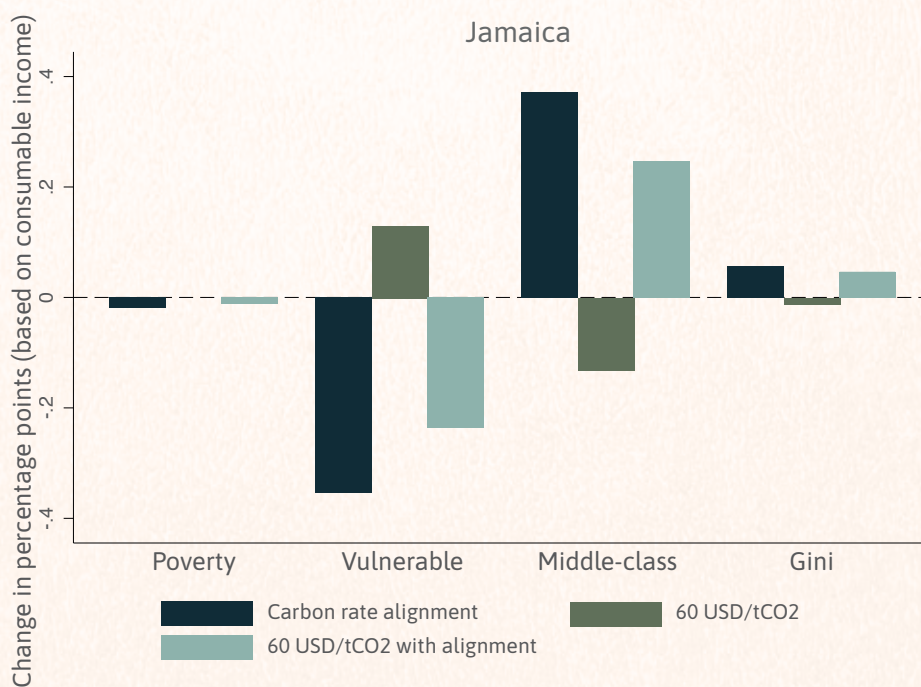
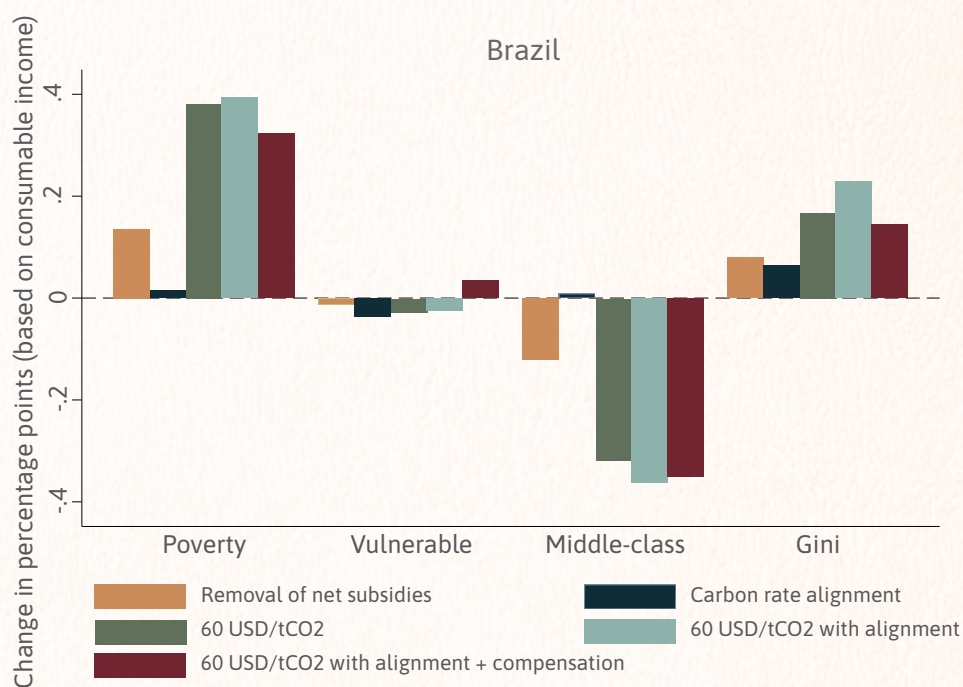


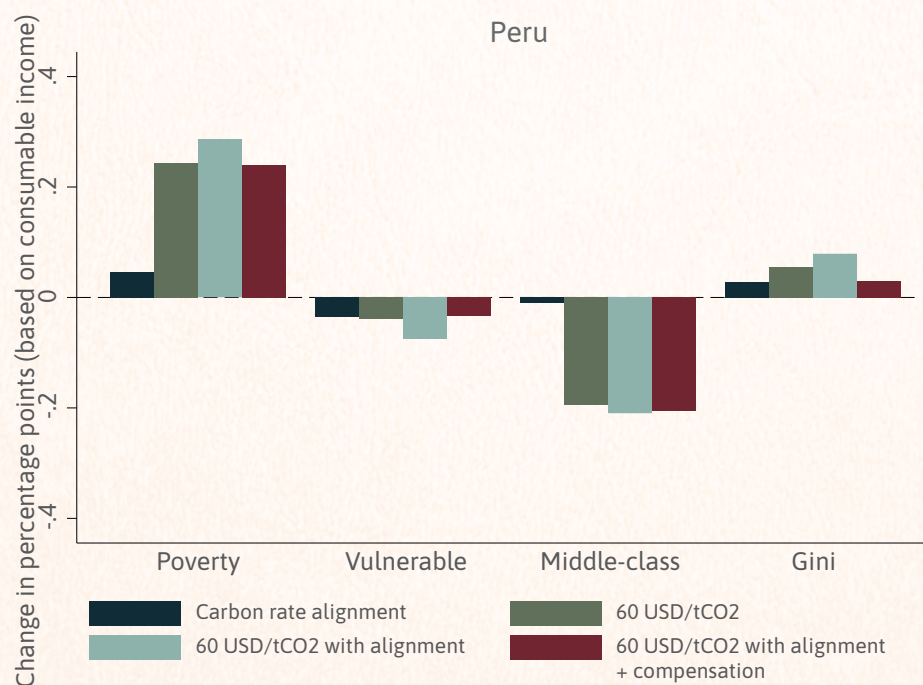
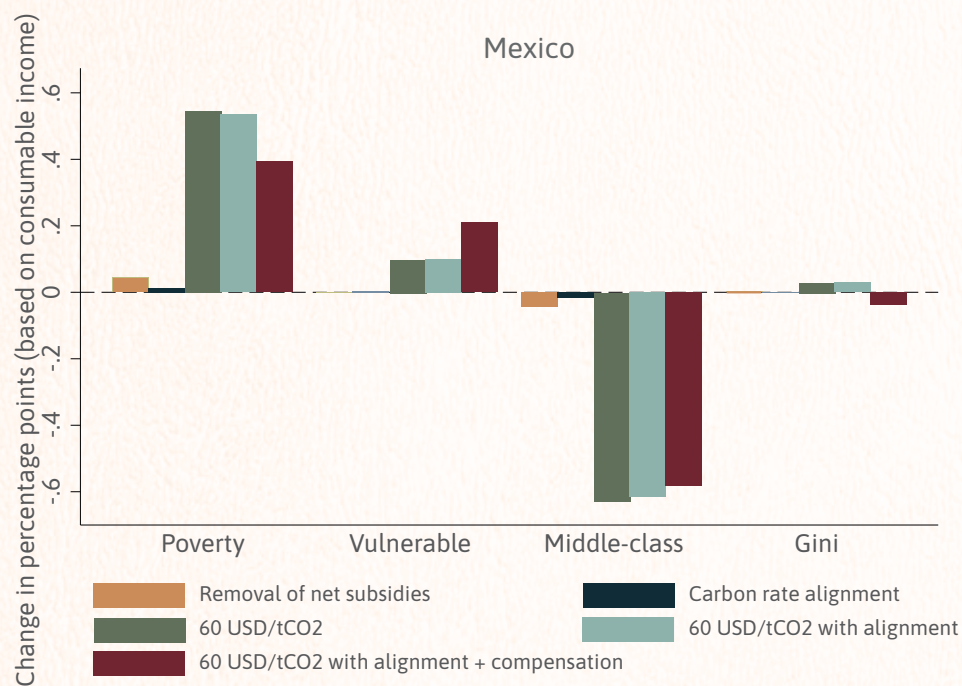


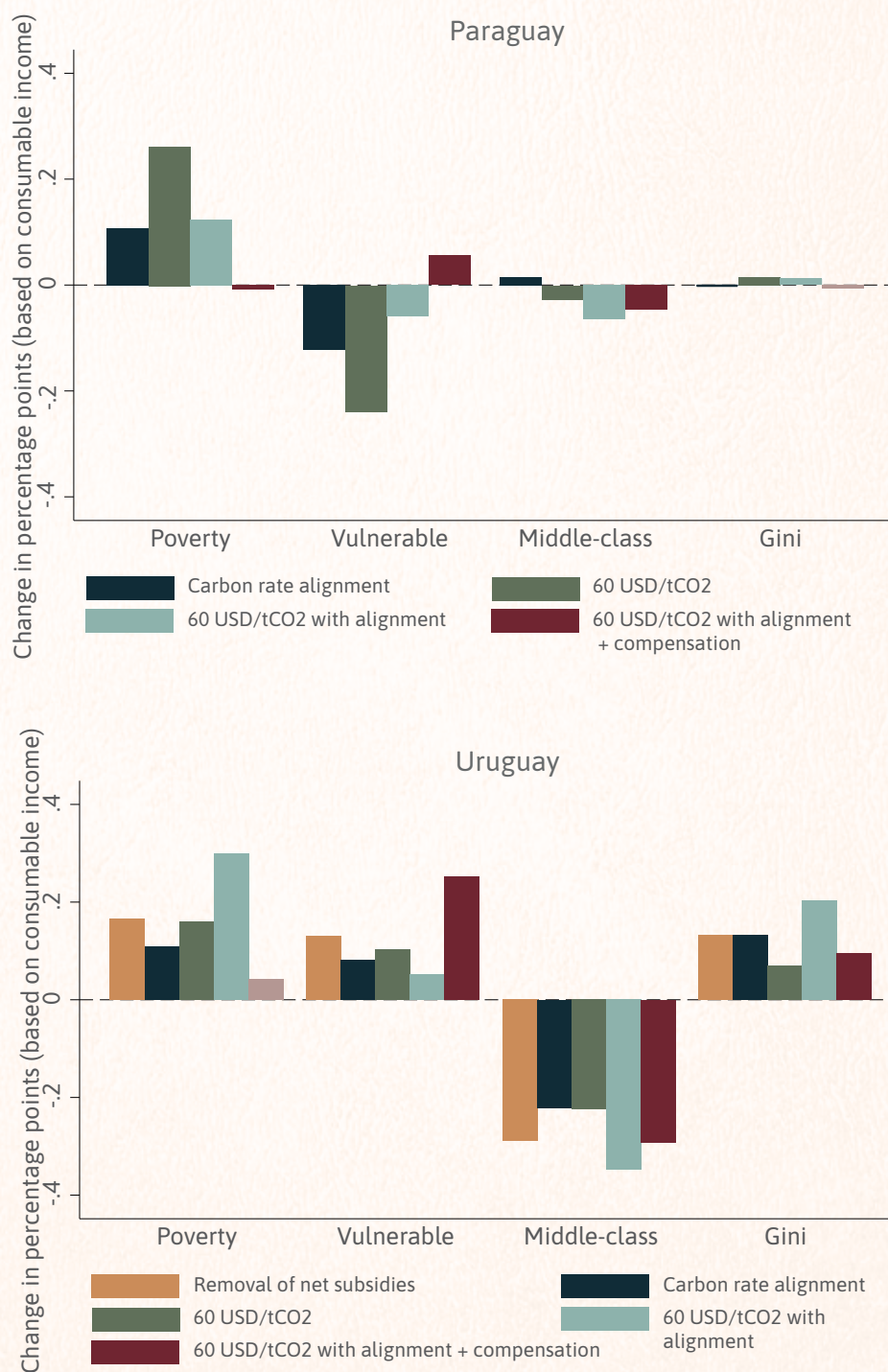
Source: World Bank calculations based on country-specific microsimulations.

Note: This figure shows the estimated percentage point change in poverty, vulnerability, and middle-class headcount ratios and the Gini coefficient between the baseline and the 25 percent price increase scenarios for each country and fuel. (For more details, refer to table C2). Statistics are calculated based on per capita consumable income and the international reference lines: the upper-middle-income poverty line (US\$6.85 per day in 2017 purchasing power parity US dollars), the vulnerability line (US\$14.00 per day in 2017 US dollars), and the middle-class line (US\$81.00 per day, 2017 US dollars).

Figure C7. Estimated changes in inequality, poverty, vulnerability and middle-class with respect to baseline scenario, by country



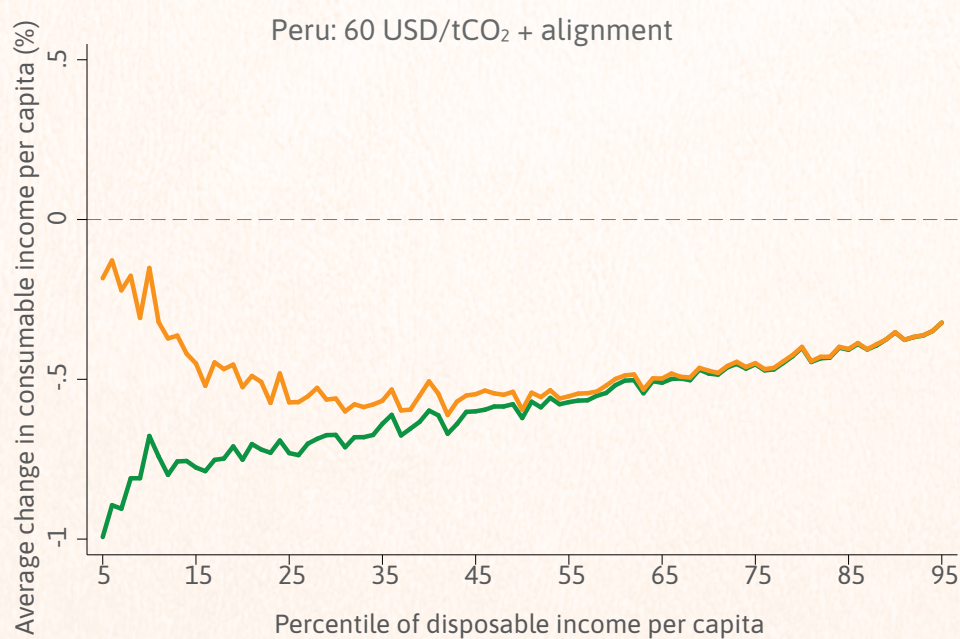
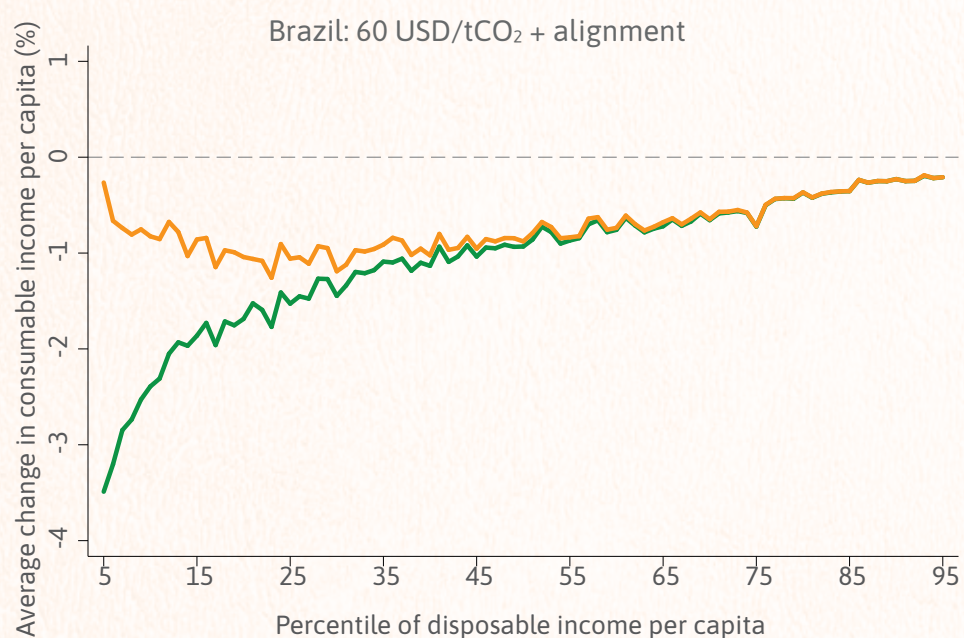




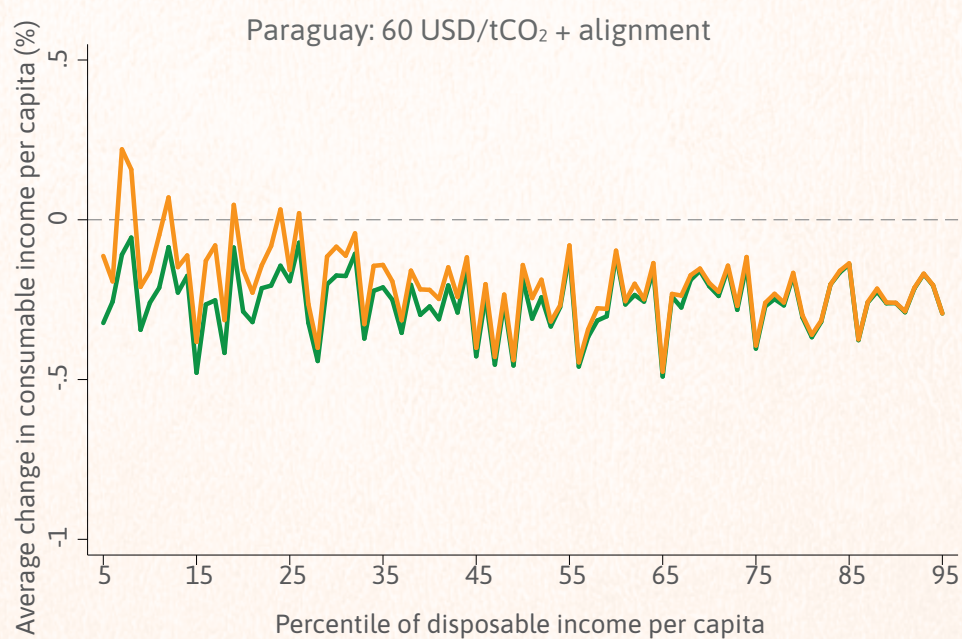
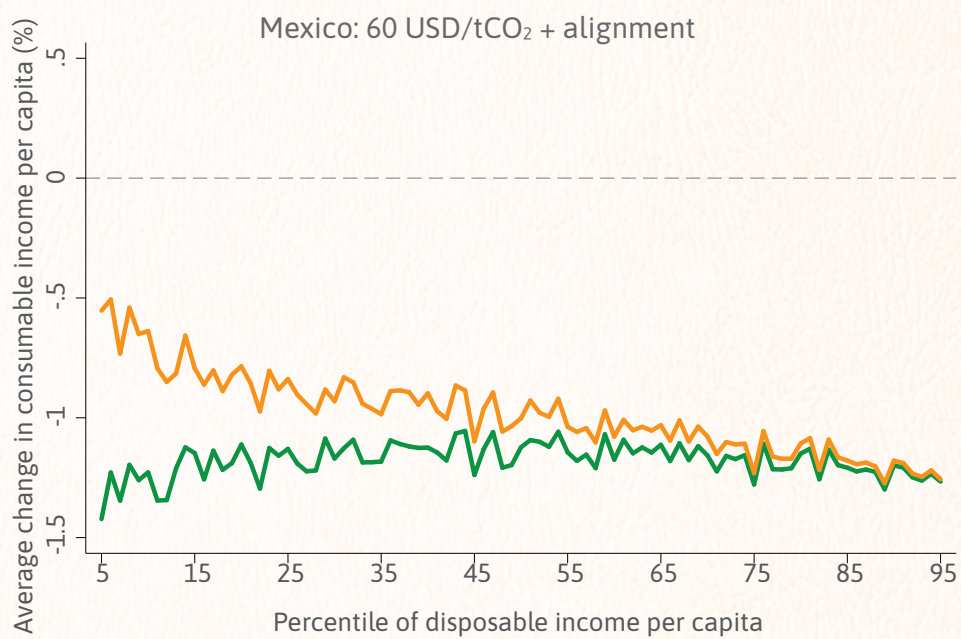
Source: World Bank calculations based on country-specific microsimulations.

Note: This figure shows the estimated percentage point change in poverty, vulnerability, and middle-class headcount ratios and the Gini coefficient between the baseline and the simulated fuel tax reform scenarios for each country. (For more details, refer to table C2). Statistics are calculated based on per capita consumable income and the international reference lines: the upper-middle-income poverty line (US\$6.85 per day in 2017 purchasing power parity US dollars), the vulnerability line (US\$14.00 per day in 2017 US dollars), and the middle-class line (US\$81.00 per day, 2017 US dollars).

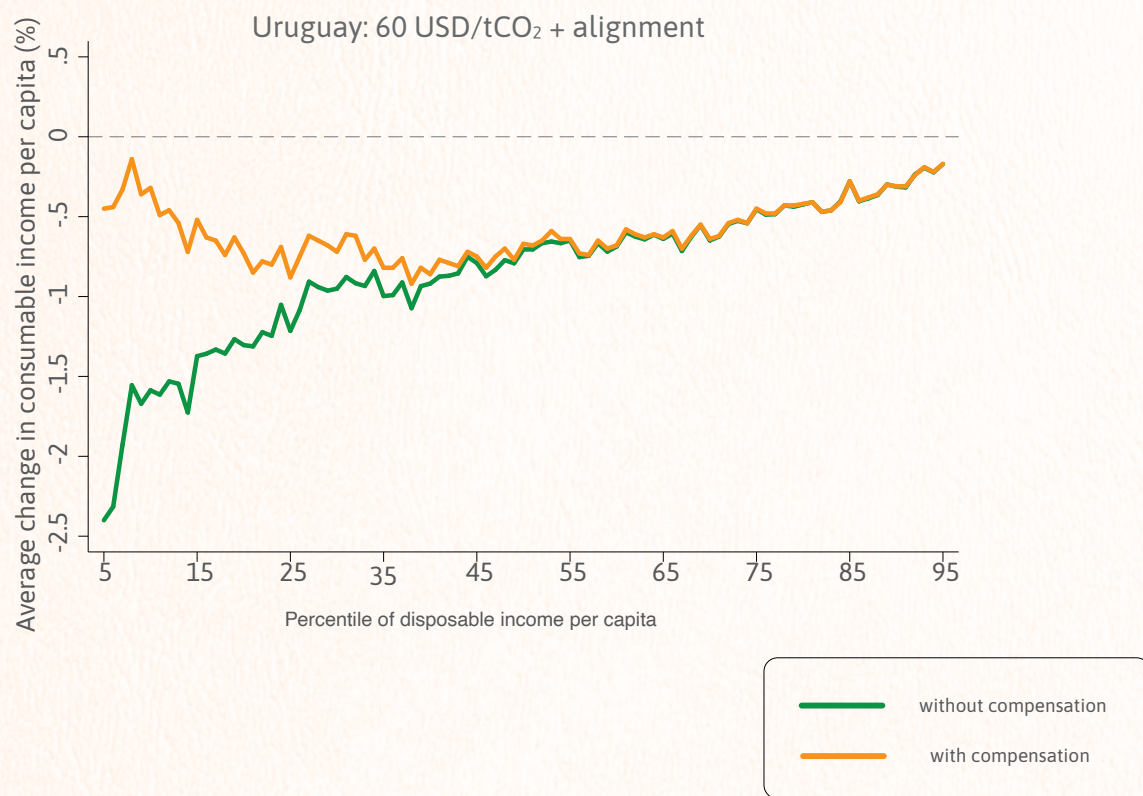
Figure C8. Estimated short-term income effects of a uniform carbon rate of US\$60 per ton of CO₂ on fuel emissions, with and without compensation policies (w.r.t. baseline scenario), by country



— without compensation
— with compensation



— without compensation
— with compensation



Source: World Bank calculations based on country-specific microsimulations.

Note: This figure shows the estimated percentage point change in per capita consumable income between the baseline and scenario 4 (defined above) relative to the case if the tax reform is accompanied by top-ups in the main social assistance programs. The results are presented as the average across households in each percentile of the per capita disposable income distribution. Individuals in the bottom and top 5 percent of the disposable income distribution are excluded because of the large variations in the data. Estimates for Jamaica are not included because scenario 4 results in an increase in per capita consumable income across the entire distribution (refer to figure 23). There is thus no need for compensation.

Annex D.

Total carbon pricing reforms in CPAT.

The CPAT exercise simulates two total carbon pricing reforms, one where all fuel's TCPs uniformly reach to US\$60 per ton of CO₂ and one scenario where only the economy wide TCP reaches US\$60 per ton of CO₂ but the TCP among fuels differs. Due to the construction and underlying assumptions of CPAT (Version 338) there remain slight differences to the empirical estimates seen in Appendix A. On the one hand, the empirical data exercise uses observed energy consumption to get emission data for all historical years (besides for 2023 and 2024 it is assumed to be equal to 2022 values) whereas CPAT uses a single year of energy consumption data as reference (2019) then makes assumptions about the evolution of the remaining years based on the fuel price changes. On the other hand, CPAT uses 2022 as the reference year and estimates each following year's data as part of the algorithm responding to price changes. Additionally, the empirical data is expressed in constant US dollars of 2022 while CPAT's is in constant US dollars of 2021. Data for each year and country was verified so that the magnitude and trend are similar.

Figure D1. Trajectory of total carbon price reforms with aligned and unaligned fuel specific TCPs used for CPAT simulation

