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ABSTRACT: EU's neighborhood countries (EUN) have lagged the EU on emissions mitigation; coal-heavy power generation and industrial sectors are a key factor. They have also trailed EU countries in emissions mitigation policies since 2000, with little use of market-based instruments, and they still have substantial fossil fuel subsidies. Increasingly stringent EU mitigation policies are associated with lower emissions in EUN. Overall output effects of the CBAM, in its current form, would be limited, though exports and emissions-intensive industries could be heavily impacted. A unilaterally adopted economywide carbon tax of $75 per ton would significantly lower emissions by 2030, with minimal consequences for output or household welfare, though a safety net for the affected workers may be necessary. To become competitive today by attracting green FDI and technology, overcoming infrastructure constraints and integrating into EU's supply chains, EUN countries would be well served to front load decarbonization, rather than postpone it for later.

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Executive Summary

The EU has been a global pioneer in the transition to decarbonize its economy and its immediate neighbors (EUN), namely, Albania, Bosnia and Herzegovina, Kosovo, Moldova, Montenegro, North Macedonia, Serbia, and Türkiye, which are heavily integrated with and reliant on the bloc through economic, financial and FDI and technology channels are likely to be significantly affected by such a transition. More immediately, the question whether the EU's carbon border adjustment (CBAM)—an import tax on carbon intensive imports—will affect its neighbors has been attracting increasing attention.

The paper assesses the performance of the EUN countries to date on emissions mitigation, their policies on that front, the extent to which they have experienced inward spillovers of tightening EU emission mitigation policies, and how further stringency in decarbonization policies in the EU in future is likely to affect them. We also study the consequences of the EUN countries trying to keep pace with the EU's carbon transition through a unilateral and upfront adoption of economywide decarbonization policies.

EUN countries have lagged the EU significantly in emissions mitigation. Their emission problem arises, mainly, from carbon-heavy power generation and industrial sectors. The high natural endowment of coal, the highest carbon emitting fossil fuel, has been a major source of cheap locally available energy. While these countries benefited from being reliant on coal during the recent energy crisis, a more sustainable way to achieving energy security will be relying more on renewables, converging to EU standards, and eventually through EU accession, directly benefiting from EU-wide policies that also help with energy security)

EUN countries' emissions mitigation policy efforts have been generally weak. They have significantly lagged EU members and have been moving only gradually towards market-based instruments since 2000. They still have substantial fossil fuel subsidies in place, and as a group, they compare unfavorably in terms of implicit subsidies, i.e., the cost of fossil fuel externalities not covered by consumer prices.

The EU's heavy push to decarbonize its own economy over the past two decades appears to have spilled over and influenced emissions mitigation in EUN countries. Our empirical findings suggest that as the EU has increased the stringency of its climate policies, the EUN countries have lowered their emissions, more so than other countries. Over the 2000-20 period, a near doubling of EU environmental policy stringency was associated with a potential reduction in emissions in EUN countries by as much as 10 to 20 percent, after controlling for other factors.

An important question we consider is how much impact CBAM will have on EUN countries in the coming years as it becomes fully operational, as well as in the more distant future when the policy is expected to be tightened further by expanding it to a wider set of the Union's imports. We find that output effects of the CBAM, once its currently proposed form is fully operationalized in 2026, would be limited, however, exports of EUN countries' emissions-intensive industries could be directly impacted, particularly metals and energy industries, and North Macedonia and Serbia are heavily exposed in this regard. Over the next decade, the EU ETS emissions cap for power and industry is set to converge to zero by 2040 and an ETS on emissions for buildings and transport is envisioned; these future developments could have spillover effects for EUN countries, though these countries have less of a catch up to do in the latter sectors. In addition, over the long run, further tightening of the CBAM could also affect the competitiveness of EUN countries given their trade integration with the EU, necessitating the tightening of emission mitigation policies.

Putting a price on carbon is the most economically efficient and equitable policy response to the emerging challenge of decarbonization in EUN. We find that the fear that a tax on carbon will adversely affect output by hitting firms and reduce household welfare, particularly for the poorer ones, is overdone. At the same time, policymakers need to be mindful of the industries that could be hit hard by a decarbonization policy and provide social assistance and safety nets, where needed. Our analysis indicates significant fiscal impact particularly when an effective recycling mechanism is in place. Under a $75 carbon tax and relative to a business-as-usual scenario, fiscal revenues from the tax would amount to about 3 percentage points of GDP on average, and it would result in an about 25 percent reduction of CO2 emissions by 2030.

Given the strong economic integration of EUN and EU, it would be in the interest of the former to keep pace with the speed of emission mitigation in the latter in future. Most of the EUN countries are at different stages on the path to EU accession and hence adhering to EU standards in this area will likely be required under the accession process. Broadly, the EU accession process would bring a host of long-term benefits, including a reorientation of the economy to achieve higher growth and living standards. Realigning the economy with EU’s climate goals and its standards on emissions would also be a key part of the accession process. An up-front adoption of a comprehensive decarbonization strategy, such as through the introduction of an economywide carbon tax, would be of greater benefit to these countries than postponing action for later.

I. Introduction

The EU has been a global pioneer in the move to decarbonize its economy and the neighboring countries at its periphery, that are heavily integrated with it, are likely to be significantly affected by such policies. The EU has been a leader in introducing sophisticated policy instruments that help with decarbonization in an economically efficient manner. The evolution of its emissions trading system, ETS, applied uniformly among all member states, is perhaps an example of the biggest experiment, globally, with a decarbonization policy. The EU's partner countries, that are deeply integrated in economic relations with it, are expected to be affected by its rapid decarbonization towards net zero by 2050. While this would apply to the EU's larger trading partners such as China and the US, it would be especially pertinent for the EMs located at the geographical periphery of the EU. Such countries, namely, Albania, Bosnia and Herzegovina, Kosovo, Moldova, Montenegro, North Macedonia, Serbia, and Türkiye, are heavily reliant on trade with the EU (their largest trading partner) and are major beneficiaries of FDI, technology and other financial flows from the Union. More immediately, the question whether the EU's carbon border adjustment (CBAM)—an import tax on carbon intensive imports meant to safeguard business competitiveness of firms in the bloc by reducing the leakage of its increasingly-strict climate policy—will affect its neighbors is gaining increasing attention.[1]

The paper focuses on EU's immediate neighborhood (EUN) countries and considers the extent to which their deep economic links with the EU have been important in inward spillovers of tightening EU emission mitigation policies, and how further change in decarbonization policies in the EU in future is likely to affect them.[2] We also analyze the consequences of the EUN countries trying to keep pace with the carbon transition underway in the EU to minimize transition costs that may arise from a late catch up down the road.

We ask the following questions:

- Where do the EUN countries stand today on carbon emissions and the mitigation policies they have in place?
- How important has the increasing stringency of EU emissions mitigation policies been for emissions reduction in EUN countries? And what would be the likely impacts of the EU's implementation of CBAM on these countries in future?
- If the EUN countries were to increase the stringency of their own mitigation policies to keep up with the EU, say through the unilateral adoption of carbon taxation, then what are the likely implications of such policies for emissions, domestic output, and household welfare, in particular?

The emission problem in the EUN countries arises, in large part, from their carbon-intense power generation and industrial sectors. The heavy reliance on coal—one of the highest polluting fossil fuels—is the main culprit. We illustrate that focusing attention on these two sectors and reducing, and eventually eliminating the footprint of coal would go a long way in bringing emission levels in these economies in line with the countries of the EU.

The EUN countries have significantly lagged the EU in implementing emission mitigation policies and while the CBAM may not have sizable immediate impact on overall output, it could have significant effects on energy-intensive sectors and overall export competitiveness over the long run. EUN countries

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[1] The CBAM entered into force on May 16, 2023.

[2] In the paper, European Union Neighborhood (EUN) comprises the following non-EU countries: Albania, Bosnia and Herzegovina, Kosovo, Moldova, Montenegro, North Macedonia, Serbia, and Türkiye, and Ukraine. Given the economic consequences of Russia's war in Ukraine we do not consider the latter in the forward-looking assessments in the paper.

have made some progress in introducing emission mitigation policies over the past two decades, though they have increasingly lagged EU members, especially in the use of market-based policy instruments. They have heavy trade integration with EU, and the CBAM, could have major impacts on exports of power, metals and commodities sectors. In addition, over the long run, the CBAM could also affect the competitiveness of EUN countries given their trade integration with the EU, necessitating the tightening of emission mitigation policies[3].

We conduct an illustrative exercise to ascertain the economywide impacts of EUN countries unilaterally adopting economywide emissions mitigation policies. Specifically, in addition to the overall effect on emissions and GDP, we study the impact on firms' costs and household consumption. Our exercise entails the introduction of an economy-wide carbon tax that is offset by recycling the additional revenue for selected fiscal measures, namely, a reduction in the labor tax wedge, and an increase in spending for health and education, capital expenditure, and targeted transfers to households.

We find that a $75 carbon tax and offsetting fiscal policies would not have negative effects on output and household consumption, though industrial firms would be affected differently depending on key characteristics. Firm level econometric analysis finds that a carbon tax would disproportionately affect firms in the industrial sector, and more generally, the cost burden of the tax could be greater on smaller, older, and more labor-intensive firms. However, the distributional impacts of carbon tax on household consumption would not be regressive in that the impact of the tax on poorer households would not be sizably more than that on those at the richer end of the distribution. The total loss of consumption would amount to only around 2-3 percent of household consumption.

The concluding section suggests a possible way forward for EUN countries through some policy choices.

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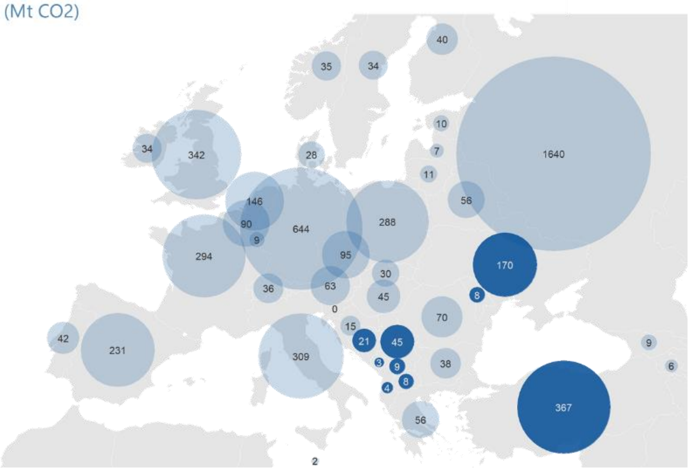
[3] The policies to address competitiveness concerns include returning revenues from industry in an output-based rebate, combine pricing with a CBAM, or use a feebate or a TPS for the industry sector.

II. Nature of Climate Issues in EU Neighborhood

The Emissions Landscape

Figure 2.1. CO2 Emissions, 2020

(Mt CO2)



Economic growth has been a key driver of rising GHG emissions, but improvements in energy efficiency have helped. The quantum of emissions in EUN countries is small in global context. The combined GHG emissions of EUN countries today (excluding Ukraine) are lower than those of Germany (Türkiye accounts for over ¾ of that; Figure 2.1). Since 2000, the carbon footprint of EUN countries has risen steadily, as growing economic activity and improving living standards boosted demand for energy. Energy efficiency has been the key to moderating the growth of carbon emissions—the EUN countries where emissions per capita increased the least were also those where improvements in energy intensity have been the greatest (Figure 2.2).

Figure 2.2. Decompostion of Changes in CO2 Emissions per Capita, 2000-2020

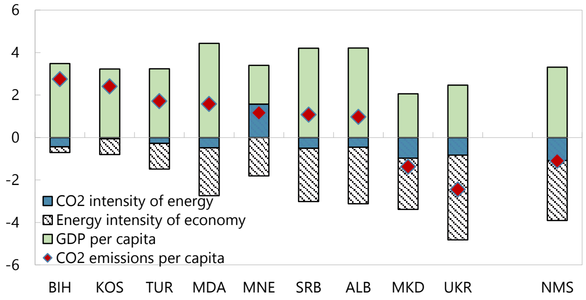
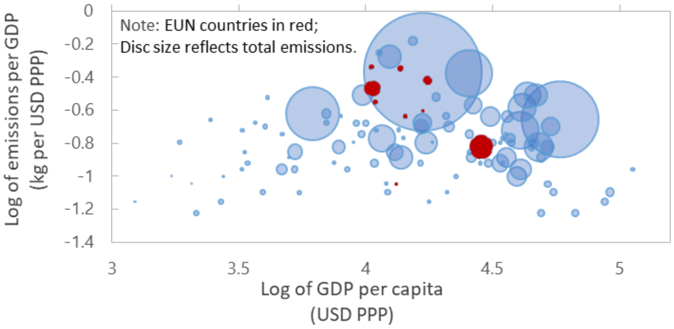


Figure 2.3. Emissions intensity of economy and income level, 2020

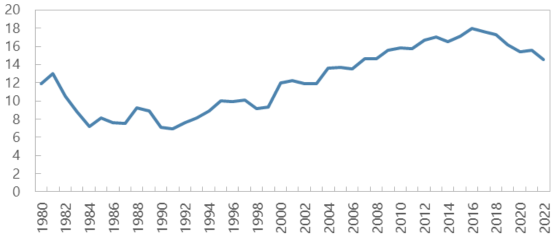

Note: EUN countries in red; Disc size reflects total emissions.

The economic output of EUN countries is highly emission intensive, but these countries may also be at a point of transition. An alternative way to judge an economy's carbon footprint is its emissions intensity of output (CO_2 emissions relative to GDP). The literature on the environmental Kuznets curve which hypothesizes that environmental costs (carbon emissions) increase in the early stages of economic convergence, and once a certain level of income is reached, further economic growth coincides with environmental remediation (Grossman and Kruger, 1991, Panayotou, 1993, and, Stern, 2004). Most of the EUN economies appear close to that tipping point (Figure 2.3). Their output is more emission intensive compared to their more developed European peers and the poorer emerging markets. But their current income level suggests that the EUN countries might be at the peak of emissions intensity of output and that further increases in income will likely have a diminishing impact on carbon emissions. While the paper focuses on emissions mitigation, it is worth noting that the EUN countries face important climate risk and adaptation issues (Box 1).

Box 1. Climate Risk and Adaptation in EU's Southern Neighborhood

Southeastern Europe is expected to be increasingly exposed to weather-related shocks through a greater frequency of heat waves, droughts, and forest fires (European Environment Agency, 2019). As global temperatures rise, subtropical climate could spread further north, degrading biodiversity and increasing the risk of new vector-borne diseases. Extreme weather events have already become more frequent in EUN countries and they account for an increasing share of weather-related disasters in Europe (Figure 2.4). Furthermore, there appears to be an inverse relationship between climate change vulnerability and resilience: countries with high vulnerability to climate change also tend to be less resilient, according to the ND-GAIN indices (Figure 2.5).

Figure 2.4. Weather-Related Disasters in EUN
(percent of events in Europe, 10-year average)



Source: EM-DAT

Figure 2.5. Vulnerability to Climate Change
(ND-GAIN, vulnerability dimension)

EUN countries face a high need to invest in resilience to protect their populations from adverse effects of climate change and stay on the economic convergence path. Adapting to climate change involves building structural resilience, post-disaster and social resilience and protecting financial resilience (IMF, 2019b). Managing and building resilience to climate risks requires adequate financial resources and state capacity. Geographic proximity of the EUN countries to the EU, association agreements and EU membership candidate status all have the potential to allow EUN countries to access EU financial support for adaptation. There is also an overlap between climate mitigation and adaptation policies. Revenues from environmental taxes (e.g., carbon tax) could be used to bolster resilience.

Sources of the Emission Problem: It's Coal

The power sector is the main source of GHG emissions in EUN countries while the carbon footprint of the other sectors is small and not much different from that in EU countries. Heat and electricity generation accounts for the largest share of GHG emissions and explains most of the variation among countries. Power plants in EUN countries produce significantly more GHG, both per capita and per unit of energy than in the more developed European countries (Figures 2.6 and 2.7). Emissions in transportation are substantially lower than in the EU, as the number of cars per capita is below EU average and the lower consumption of goods per capita translates into lower freight volumes. Finally, emissions from buildings appear to be much higher in the EU than EUN countries, however some of the difference might be due to IPCC standards of GHG reporting of emissions from burning wood (IPCC, 2019).

Figure 2.6. Sectoral CO2 Emissions in EUN over time
(MT of CO2/person; average)

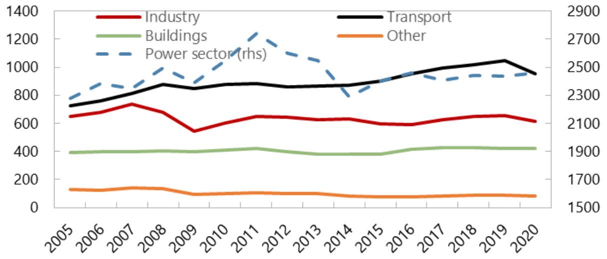
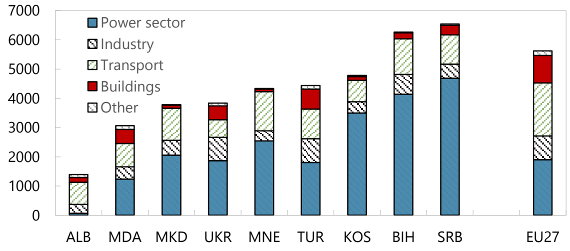
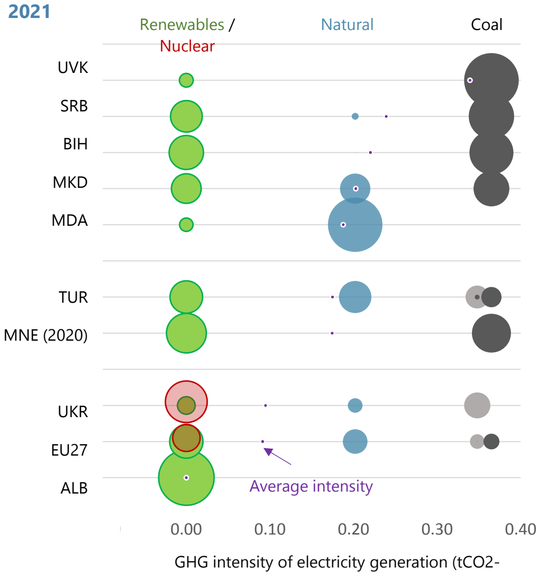


Figure 2.7. Sectoral CO2 Emissions in EUN, by country
(MT of CO2/person)



The fuel mix is to blame for the high emissions intensity of electricity generation in most EUN countries. Coal remains the backbone of energy systems as many of the EUN countries are endowed with deposits of lignite—the most CO_2-intensive grade of coal. For example, in Kosovo, Serbia and Bosnia and Herzegovina, lignite accounts for more than 60 percent of electricity generation (Figure 2.8). Other countries depend on imported natural gas (Moldova), while only Ukraine uses nuclear power.[4] At the other end of the spectrum, Albania, heavily relies on hydroelectricity, which accounts for most of the renewable energy in the Western Balkans, though it also imports electricity. Coal is also an important fuel in residential heating. While the share of coal in household energy consumption has been declining, it remains significantly above EU levels in Bosnia and Herzegovina, Moldova, Serbia and Türkiye. Separately, coal and wood burning also contributes to air pollution (see Box 2.), resulting in particulate matter concentration significantly above WHO standards. The speed with which coal is phased out would be critical in determining how quickly many of the EUN countries decarbonize.

Figure 2.8. Electricity Production Structure, 2021



Box 2. Local Air Pollution

EUN countries have the highest levels of air pollution in Europe today. The concentration of particulate matter, specifically PM2.5, which has the most significant impact on health outcomes, ranges from 11 to 30 µg/m3. These levels substantially exceed WHO guidelines (5 µg/m3). It is estimated that air pollution is responsible for nearly one in ten deaths in Türkiye, North Macedonia, Bosnia and Herzegovina, and Serbia, and more than five percent of deaths in other EUN countries. In Western Balkan countries, the power sector is the single biggest source of PM2.5 pollution, followed by combustion in residential sector, and agriculture. Industrial activities and road traffic also exert a significant local-level impact. Air pollution is also caused by high prevalence of biomass combustion in residential sector and heavy reliance on coal.

The costs associated with poor air quality caused by fossil fuels are estimated at up to 20 percent of GDP in EUN countries, primarily attributed to coal. These externalities, which are not reflected in prices, effectively

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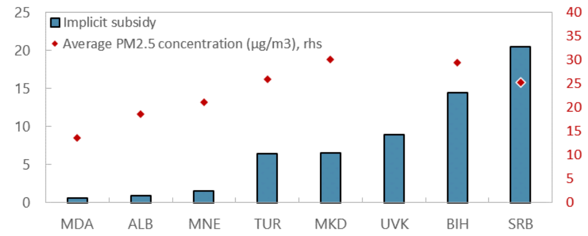
[4] Türkiye is expected to connect first nuclear power plant to the grid in 2024.

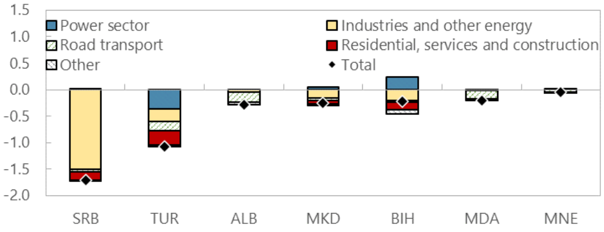
result in implicit subsidy to fossil fuels. To reflect the detrimental effects on health, the prices of coal would need to increase multifold, rendering it an uncompetitive source of energy.

While a carbon tax does not directly target air pollution, it would play a crucial role in facilitating phase-out of coal, thereby mitigating its adverse impact on air quality. While a gradual implementation of carbon tax to reach $50-$75 in 2030 (as reflected in the exercise below) would lead to modest decline in average PM2.5 concentration, it would lead to a reduction of more than 2,000 air-pollution-related deaths in Western Balkans and Moldova by 2030, with the most significant improvements expected in Serbia. Furthermore, better air quality will yield additional benefits, such as reduced healthcare costs, increased productivity, and preventing long-term consequences for child development.

Fossil Fuels Externalities related to Local Air Pollution, 2020
(percent of GDP)



Impact of $75 Carbon Tax: Change in PM2.5 Concentration by 2030 (µg/m3)



Emission Reduction Targets: Ambition Versus Realism

National emissions targets for some EUN countries are not ambitious in the context of the required global effort. Global GHG emissions need to be cut by at least 50 percent by 2030 from 1990 level to keep global temperature increase below 1.5°C. The Paris Agreement obliges signatory parties to set increasingly ambitious targets, or, Nationally Defined Contributions (NDCs), every five years. All EUN countries have declared NDCs, and most have signed the Paris Agreement (see Table 2.1)[5]. The Paris Agreement does not impose any stringency on NDCs and leaves the pace of emission reduction, and its benchmarks and coverage at the discretion of countries. NDCs for some EUN countries are not ambitious in the context of the required global effort. They imply an *increase* in emissions between 2018 and 2030 in Albania, Serbia, and Türkiye. Emission reduction in the other EUN countries will be close to 16 percent, on average (excluding Ukraine), over the same period (Figure 2.9).

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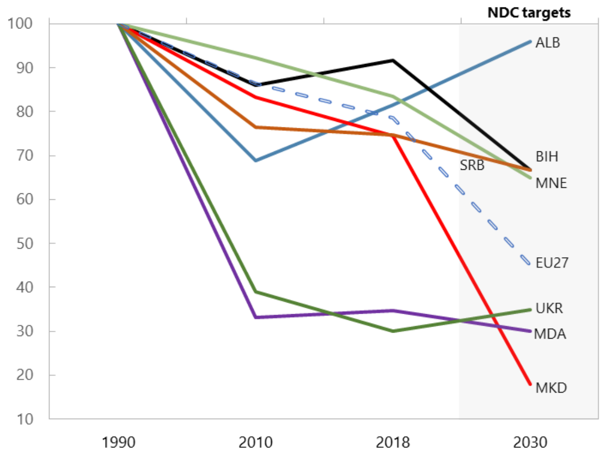
[5] Given its status, Kosovo is not a party to the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, and therefore not required to submit NDCs. Nevertheless, Kosovo has signed the Sofia Declaration outlining climate goals for the Western Balkan countries and the authorities are developing the National Energy and Climate Plan 2025-30.

Table 2.1. NDC Targets in EUN Countries

Country	Type of GHG	Benchmark*	Reduction target for 2030 (absolute emissions)	Sectors covered**
EU-27	**CO2, CH4, N2O, HFCs, PFCs, SF6, NF3**	**Base year 1990**	**55%**	**ENE, IND, AGR, WST, LULUCF**
Albania	GHG	BAU	20.9%	ENE, IND, AGR, WST, LULUCF
Bosnia and Herzegovina	CO2, CH4, N2O, HFCs	BAU	33.2% (unconditional) 36.8% (conditional)	Economy-wide, incl. LULUCF
Moldova	CO2, CH4, N2O, HFCs, PFCs, SF6, NF3	Base year 1990	70% (unconditional) 88% (conditional)	ENE, IND, AGR, WST, LULUCF
Montenegro	CO2, CH4, N2O, HFCs, PFCs, SF6	Base year 1990	35%	ENE, IND, AGR, WST
North Macedonia	CO2, CH4, N20	Base year 1990	82%	ENE, IND, AGR, WST, LULUCF
Serbia	CO2, CH4, N2O, HFCs, PFCs, SF6	Base year 1990	33.3%	ENE, IND, AGR, WST
Turkey	GHG	BAU	21%	Economy-wide excl. LULUCF
Ukraine	CO2, CH4, N2O, HFCs, PFCs, SF6, NF3	Base year 1990	65%	ENE, IND, AGR, WST, LULUCF

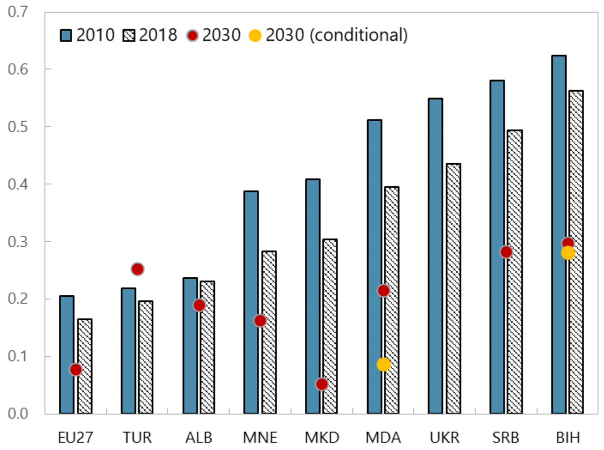
* BAU - Business As Usual
** ENE - Energy, IND – Industrial processes, AGR – Agriculture, WST – Waste, LULUCF – Land Use, Land-Use Change and Forestry

Figure 2.9. GHG emissions and NDC targets
(index, 1990=100)



Note: NDC target for Turkey implies five-fold increase in GHG emissions by

Figure 2.10. Emissions Intensity of Output implied by NDC targets
(kg of CO2eq./USD PPP)



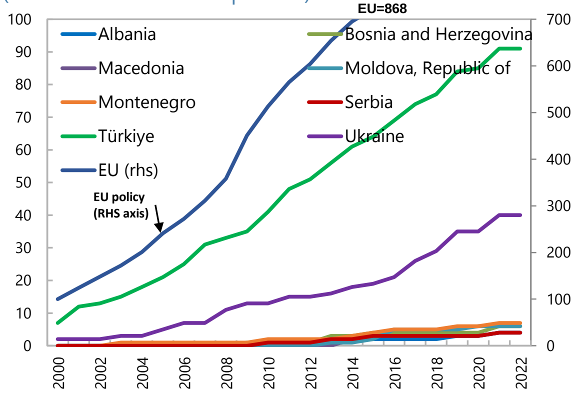
Even achieving the not-so-ambitious NDC targets will require significant policy effort. While it is absolute emissions that matter for mitigating climate change, the realism and ambition of NDCs in EUN can perhaps be better assessed through the *effort* they imply. One way to assess effort is by ascertaining what emission reduction targets in NDCs imply for future emissions in relation to economic output (figure 2.10) and comparing them with what was achieved between 2010 and 2018. The NDC targets imply an improvement in emissions-output ratio by 2030 in all countries except Türkiye. The targets for 2030 imply a level of effort that would be significantly greater than what these countries undertook in the 2010-18 period. North Macedonia stands out as an ambitious country in the sample which aims to converge to the level envisaged for the EU by 2030. Decarbonization will require a better mix of policies, including taxes, subsidies, and administrative measures. To illustrate the policy effort required to achieve the NDC targets, we estimate below the potential emission reductions that could be achieved through the imposition of an economy-wide carbon tax, of $50 or $75 per ton. The calculations, which are discussed in greater detail in section 4., suggest that only the relatively unambitious target set by Albania, Serbia, and Türkiye would be achievable by 2030 under a $75 dollar/ton carbon tax. In the other EUN countries, significantly greater policy effort, or a much higher carbon tax rate, or both will be needed.

III. Policies and Spillovers

Evolution of emissions mitigation policies in EUN countries

EUN countries have made some progress in introducing emission reduction policies since 2000, but they lag EU members in this regard. Detailed information on emission mitigation policies implemented in the EUN countries, including their stringency and effectiveness, is not available. We employ a recently available *Climate Policies Database* from the New Climate Institute which documents a time series of the *number of policies* implemented by type and sector (see Annex 3 for details). The trend since 2000 in EUN countries on climate policy implementation has been varied, but all of them have diverged substantially from the EU. Some countries, though, have made notable progress--Türkiye saw the greatest increase over the past two decades in the number of policies implemented. (Figure 3.1).

Figure 3.1. Climate Policy by Country and Year
(Cumulative number of polices)



Sources: New Climate Institute and IMF Staff Caculation
Note: NDC targets for ALB and TUR imply an increase in emissions from 1990 levels.

EUN countries have been moving only gradually towards market-based instruments. From a theoretical standpoint, while market instruments such as carbon taxes offer a comprehensive way of reorienting the economy away from carbon, other instruments may not be substantially inferior (Chateau and others, 2022). Further, some market instruments like an explicit carbon tax are less acceptable to the public than “hidden” measures such as targets, regulations and standards. There is also some evidence that the likelihood of adopting market-based instruments rises with country income, and given their lower incomes compared to richer countries, EMDEs are more likely to use non-market instruments (Linsenmeier and others, 2022). Not surprisingly, EUN countries mainly rely on regulatory measures, policy support, and targets as policy instruments though there has been a gradual increase, over time, in the adoption of economic instruments (see Figure 3.2).[6] In 1994, the most commonly used policy in all the sectors in EUN countries was regulatory instruments, but by 2022, two important sectors, electricity and heat, and buildings, were commonly using economic instruments. Notwithstanding the gradual pace of introduction of economic instruments in EUN countries, and the fact that no EUN country employs meaningful carbon taxation or ETS[7], the evolution of policies over time does suggest an evolution over time toward market instruments.

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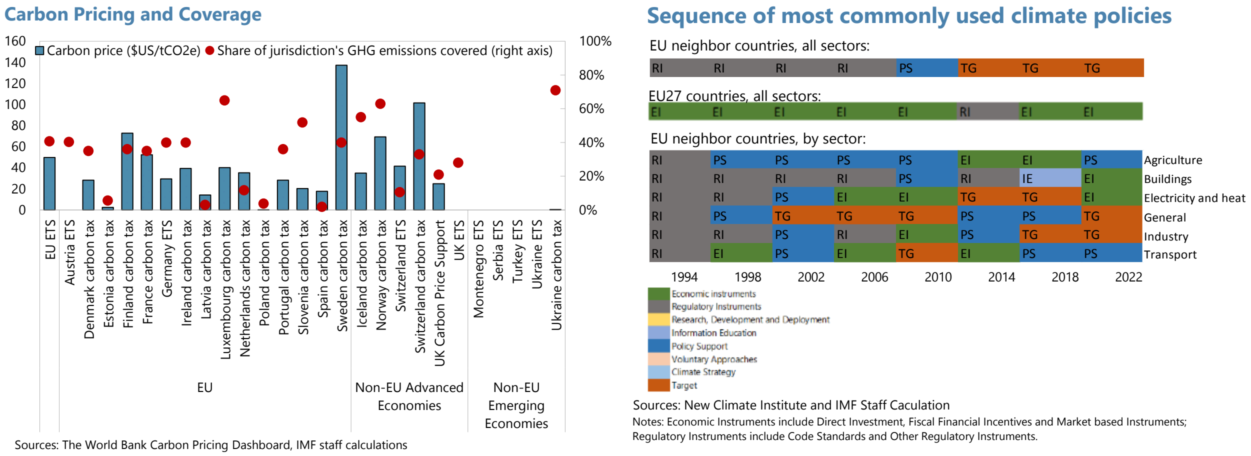
[6] Specifically, *regulatory measures* entail setting environmental or industrial standards, such as product or vehicle emission standards. *Policy support* involves establishing institutions, strategic priorities, or roadmaps for emissions mitigation in specific sectors, or the economy at large. *Setting targets* involves enshrining sectoral or economy-wide targets into law.

[7] Ukraine signed as Association Agreement with the EU in 2017 under which it committed to introducing an emissions trading system.

Figure 3.2. Climate Change Mitigation Policies



Sources: The World Bank Carbon Pricing Dashboard, IMF staff calculations

	1994	1998	2002	2006	2010	2014	2018	2022
EU neighbor countries, all sectors:	RI	RI	RI	RI	PS	TG	TG	TG
EU27 countries, all sectors:	EI	EI	EI	EI	EI	RI	EI	EI
EU neighbor countries, by sector:								
Agriculture	RI	PS	PS	PS	PS	EI	EI	PS
Buildings	RI	RI	RI	RI	PS	RI	IE	EI
Electricity and heat	RI	RI	PS	EI	EI	TG	TG	EI
General	RI	PS	TG	TG	TG	PS	PS	TG
Industry	RI	RI	PS	RI	EI	PS	TG	TG
Transport	RI	EI	PS	EI	TG	EI	PS	PS

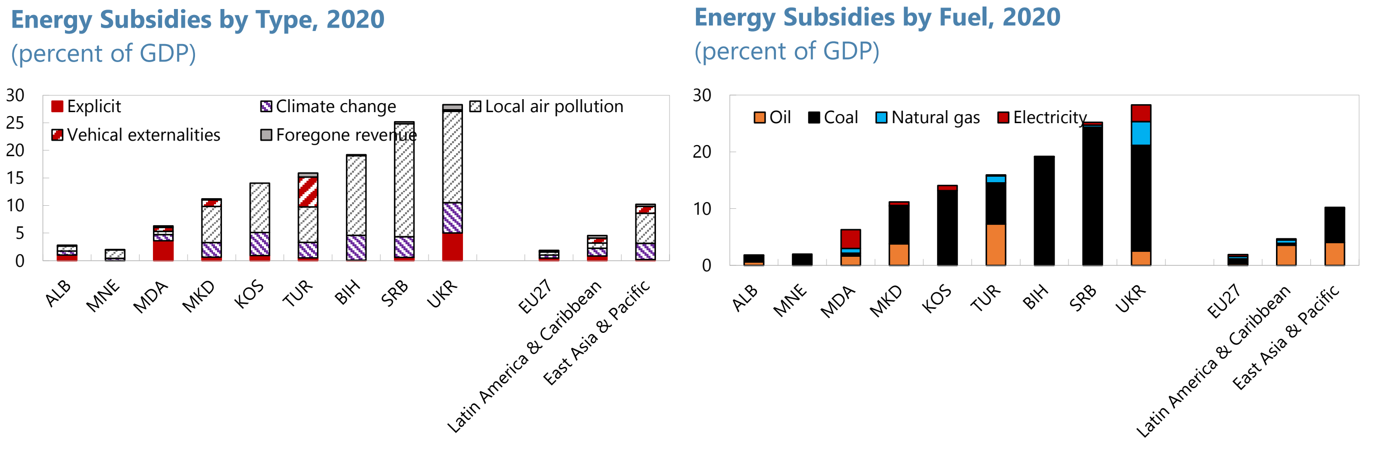
Sources: New Climate Institute and IMF Staff Caculation

Notes: Economic Instruments include Direct Investment, Fiscal Financial Incentives and Market based Instruments; Regulatory Instruments include Code Standards and Other Regulatory Instruments.

Explicit fossil fuel subsidies in EUN countries are substantial. Measured as the gap between domestic and international prices, such subsidies amount to (1.5 percent of GDP on average; Figure 3.3). Explicit subsidies are significantly higher in EUN countries than in other EMs—they amount to 0.2 and 0.9 percent of GDP in Asia and Latin America and the Caribbean, respectively. The average masks a stark intra group variation between the Western Balkan countries, where the subsidy cost is below 1 percent of GDP, and Ukraine and Moldova, where it exceeds 3 percent of GDP.

The EUN countries, as a group, also compare unfavorably in terms of implicit subsidies, i.e., the cost of fossil fuel externalities not covered by consumer prices. Local air pollution is the largest cost component in most of the countries, capturing the impact on health outcomes (see Box1, above), followed by climate change—an effect of GHG emissions. Most of the implicit fossil fuel subsidies can be attributed to the prevalence of coal.

Figure 3.3. Energy Subsidies


Energy Subsidies by Type, 2020
(percent of GDP)

Energy Subsidies by Fuel, 2020
(percent of GDP)

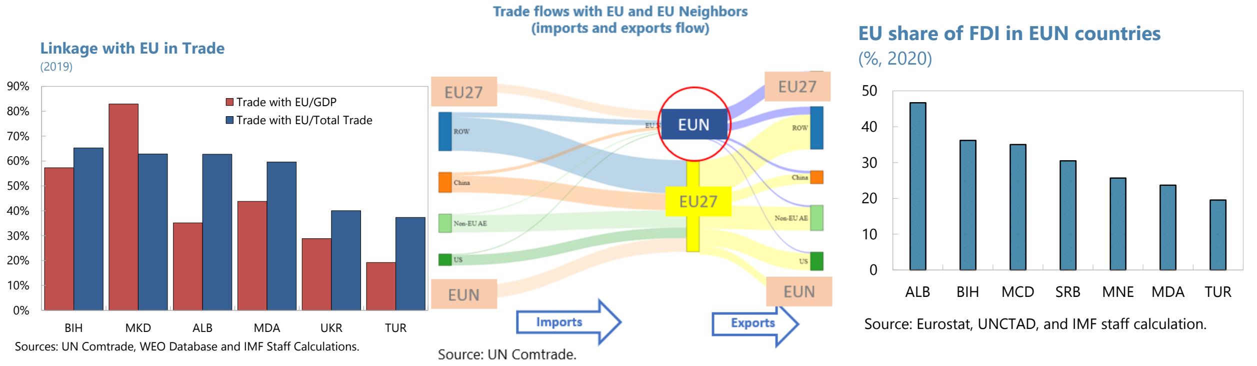
Source: IMF, Energy Subsidy Template, September 2021.

EU Policy Spillovers: Empirical Evidence

The EUN economies are integrated with the EU, mainly through trade, which is a potential channel for emission mitigation policy spillover from the latter. The EU-EUN trade integration is underpinned by various agreements and partnerships, including the European Neighborhood Policy and the Eastern Partnership. As shown in Figure 3.4, EU is the largest trading partner for most of the EUN countries, accounting for more than half of total trade for all Western Balkan countries, and particularly so for Bosnia and Herzegovina, North Macedonia, Albania and Moldova where this share is near 60 percent.[8] Trade integration has also been on a rising trend—Western Balkan countries' exports to the EU have doubled over the past 10 years. Beyond trade, the EU is also the largest source of incoming FDI and other financial flows.

There are several channels through which EU's increasingly stringent emissions mitigation policies could spill over to neighbors. Such spillovers could be unfavorable, in that they raise emissions in EUN countries, if a tightening of emissions policies in EU result in leakage—e.g., EU produciton relocates to neighboring countries where carbon emissions are not taxed or regulated as much as they are in the EU. On the other hand, spillovers could be favorable, in that they lower emissions in EUN countries, in serveral ways. First, continual carbon saving techonological innovations in the EU could reduce mitigation and green transitional costs in EUN countries. Second, a tightening of emissions mitigation policies in EU could create incentives through international trade—e.g., if EU producers' import demand for goods with low carbon inputs increases. Third, EU's economic influence, including through its financial and technical assistance to neighbor countries, could nudge EUN economies to adopt similar mitigation policies and practices. Recent empirical studies point to the existence of such spillovers—in the form of international trade in intermediate goods (e.g. export and import of equipments and machines), foreign direct investment (e.g. multinational firms' transfer of clean production and technology abroad), and private investment (e.g. Dolphin and Pollitt, 2021, Linsenmeier and others, 2022).

Figure 3.4. EUN Countries' Trade Relations with EU



Linkage with EU in Trade
(2019)

Sources: UN Comtrade, WEO Database and IMF Staff Calculations.

Trade flows with EU and EU Neighbors
(imports and exports flow)

Source: UN Comtrade.

EU share of FDI in EUN countries
(%, 2020)

Source: Eurostat, UNCTAD, and IMF staff calculation.

Our empirical analysis points to some evidence of favorable (emissions-reducing) spillovers of EU climate mitigation policies on EUN countries. To assess whether EU's climate mitigation policies influence emissions in its smaller neighbors in EUN, we use panel data sets for over 100 countries over the 2002-19 period and regress country CO_2 emissions on the stringency of EU climate policies, while controlling for income, squared income, and regulatory quality. We also employ country and time fixed effects. The results in

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[8] The EU's main imports from the Western Balkans are: machinery and appliances (23 percent), base metals (14 percent), mineral products and chemicals (11 percent each). The Western Balkans region also exported 53 terawatts of power to the EU between 2017 and 2021, amounting to 14 percent of its own electricity production (IEA).

Table 3.1 show that greater EU environmental policy stringency[9] is associated with lower CO_2 emissions in EU countries themselves, as would be expected, but it is also associated with lower emissions in EUN countries. The estimated coefficient for EUN countries is both economically and statistically significant, namely, a 10 percentage points increase in EU environmental policy stringency is associated with a reduction of about 1 percent in CO_2 emissions in EU countries themselves, and an additional 1 to 3 percent reduction in CO_2 emissions in EUN countries. Between 2000 and 2020, EU environmental policy stringency more than doubled, increasing from about 1.6 to 3.5. This suggests a potential reduction in emissions in EUN countries through the spillover effects of EU environmental policy, by as much as 10 to 20 percent.

Table 3.1. CO2 Emissions and EU Climate Policies

	Dependent Variable: CO2 per capita			
	(1)	(2)	(3)	(4)
GDP(real, ppp, log)	0.76***	0.75***	3.40***	3.50***
	(0.03)	(0.03)	(0.15)	(0.16)
GDP square (real, ppp, log)			-0.15***	-0.15***
			(0.01)	(0.01)
EU Climate Stringency	-0.12***	-0.13***	-0.11***	-0.11***
	(0.01)	(0.01)	(0.01)	(0.01)
EU Climate Stringency * Dummy for EUN	**-0.11*** **	**-0.14*** **	**-0.08*** **	**-0.11*** **
	(0.03)	**(0.04)**	**(0.03)**	**(0.03)**
Country regulatory quality		0.05***		0.05**
		(0.02)		(0.02)
Constant	-5.96***	-5.83***	-17.36***	-17.77***
	(0.23)	(0.26)	(0.67)	(0.73)
Year fixed effects	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
Observations	2,517	2,392	2,517	2,392
R-squared	0.31	0.31	0.40	0.39
Number of Countries	126	126	126	126

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

EU Policy Spillovers: Carbon Border Adjustment Mechanism

The EU's CBAM is a significant step in the evolution of its climate mitigation policy to drive a collective effort towards a sustainable and low-carbon global economy. The EU has been at the global forefront in tackling climate change by introducing increasingly ambitious and sophisticated policies, including EU ETS, *Effort Sharing Regulation*, transport and land legislation, all aimed at achieving carbon neutrality by 2050. To safeguard business competitiveness and reduce carbon policy leakage[10], the sectors exposed to high leakage currently receive a greater share of free allowances under the ETS. However, to further align its climate policies with global competitiveness and remove incentives for carbon leakage, the EU has put into force CBAM in 2023, which, when operational, would amount to an import tax on imbedded carbon of certain carbon-intensive goods from non-EU countries. The Mechanism aims to preserve a level playing field for EU producers and promotes explicit or implicit pricing of carbon in other countries, while attempting to remove the disparate

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[9] The Environmental Policy Stringency index is a measure of the overall strength and effectiveness of environmental policies and regulations implemented by the European Union. It accounts for the various policy measures used to address environmental challenges, such as climate change, air and water pollution, and bio-diversity loss. These policy measures may include emissions targets, regulations on industrial emissions, renewable energy targets, and measures to promote energy efficiency, among others (see OECD, 2022).

[10] Carbon policy leakage occurs when an increase in stringency of EU climate policies either induces EU businesses to relocate production abroad to countries with weaker policies, or encourages foreign producers to increase output and export to the EU, or both.

incentives between domestic and foreign producers. By incentivizing carbon mitigation overseas and encouraging trading partners to adopt domestic carbon pricing, the EU aspires to achieve efficient carbon emission reduction within a fairer and more sustainable trading system. Trading partners that have already made progress in transitioning to greener production methods can maintain their competitive edge, while also encouraging other nations to adopt environmentally friendly technologies and practices.

The implementation of CBAM is expected to be gradual, and it will apply to carbon-intense sectors and products. Once the CBAM is fully operational in 2026 (see Box 3 for a timeline), its implementation will go in lockstep with the removal of free allowances that domestic EU producers in carbon-intensive industries currently enjoy under the ETS. On paper, the policy could have potentially significant implications for the EU's trading partners, with the sectors with the highest carbon intensity the most at risk—namely metal, chemical, wood, textile, transportation equipment, and other EITE industries[11]. These sectors may face significant challenges in adapting to the new regulatory environment, as they will have to find ways to reduce their carbon footprint or pay additional costs to comply with the CBAM.

Box 3: Implementation Timeline of Border Carbon Adjustment (CBAM)

In mid-2021, the European Commission (EC) made a series of legislative proposals, dubbed *Fit for 55* Package, to pave the way for meeting EU's interim decarbonization target for 2030. The world's first BCA (or Border Carbon Adjustment Mechanism, CBAM, in EU terminology) was a key element of the Package. Following the negotiations between the EC, the European Parliament, and the Council of Europe, the CBAM was approved and it entered into force on May 16, 2023.

Full operationalization will take three years. The transitional period is scheduled to start on October 1, 2023, with the regulations becoming fully effective in 2026. During transition, the EU will not collect CBAM payments, but importers of carbon-intensive products will be required to report data on embedded GHG emissions to the CBAM authority.

Linked to full operationalization of CBAM is the introduction of carbon leakage mitigation measure—the concurrent retirement of free EU ETS allowances for EU industry. The number of free allowances will be gradually reduced in CBAM sectors by 48.5 percent between 2026 and 2030, with full phase out scheduled for 2034. The EU expects that subjecting domestic producers to carbon pricing will ensure compatibility of CBAM with international rules on trade.

Based on our analysis, EUN countries will face varying degrees of foregone revenues subject to CBAM. The destination of the revenues the EU will collect under the CBAM is yet to be determined (as under one proposal, they could be recycled as transfers to countries whose firms pay). In the paper we assume that the revenues are not recycled to paying countries. The EUN countries' exports that fall under the current classification of CBAM goods account for less than 5 percent of GDP and around 15 percent of total exports (See Figure 3.5). Using the revenue calculation methodology from IMF (2022), we find that potential or

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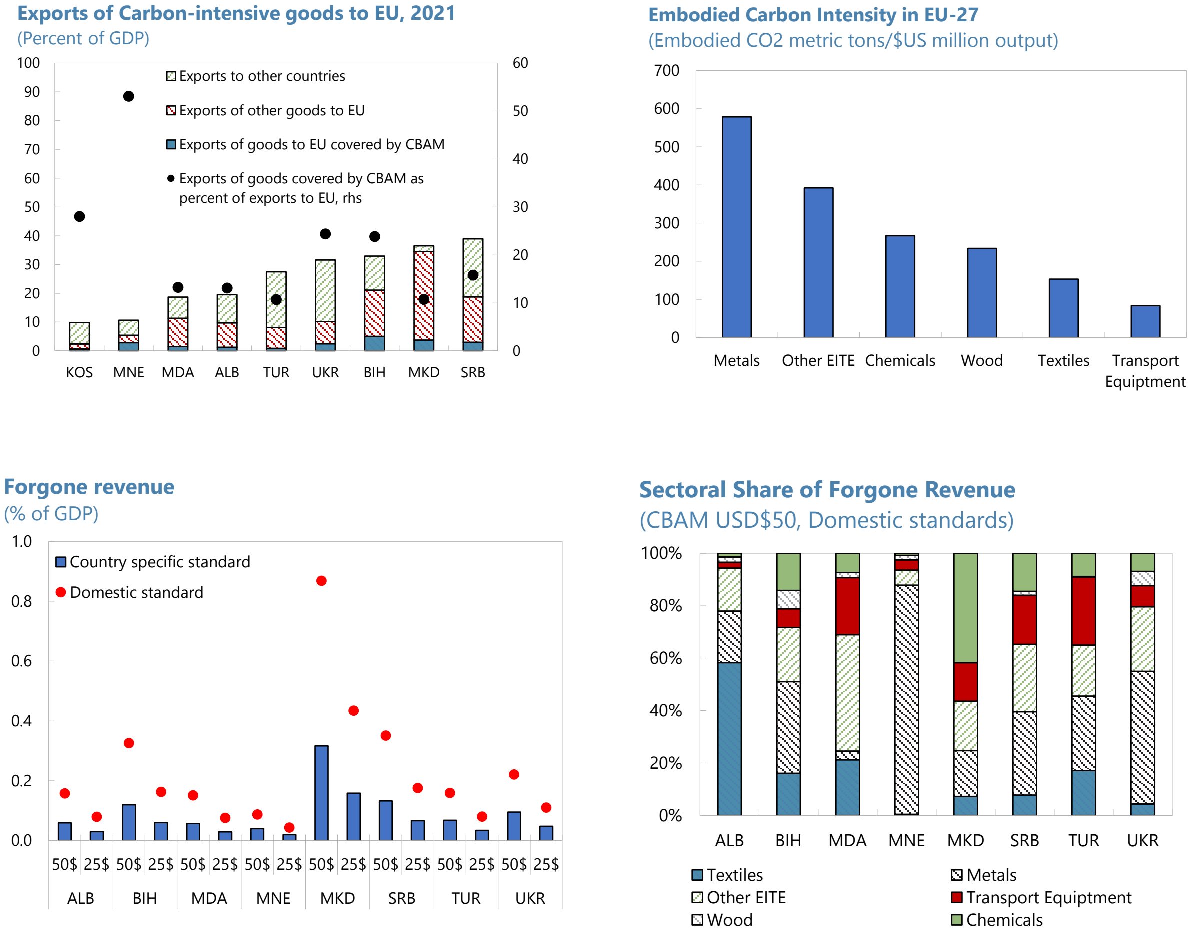
[11] "Chemicals" sector refers to chemicals and pharmaceutical products; "Metals" refers to manufacture of basic metals, fabricated metal products except machinery and equipment; "Textiles" refers to textiles, wearing apparel, leather and related products; "Transport Equipment" refers to motor vehicles, trailers and semi-trailers and Other transport equipment; "Wood" refers to wood, products of wood and cork (except furniture); "Other emission intensive trade exposed (EITE)" refers to food products, beverages and tobacco, paper products and printing, computer, electronic and optical products, machinery and equipment n.e.c. and other non-metallic mineral products.

foregone revenues could be large.[12] For example, North Macedonia, whose exports of CBAM goods would comprise 11 percent of total exports, will possibly experience the biggest impact of all EUN countries by having to forego 0.9 percent of GDP per year if EU imposes a $50 per ton CBAM on its exports of carbon-intensive goods to EU using exporting country's domestic standard (the foregone revenue for $75 per ton CBAM would be proportionally higher). Other EUN countries would have lower forgone revenues, ranging around 0.1–0.4 percent of GDP. If applying EU's carbon intensity standard, which is lower than EUNs', the foregone revenues will be smaller. The burden of EU CBAM would fall most heavily on industrial sectors, such as metals and commodities (Figure 3.5). In the current proposed form, with narrow application to only carbon-intensive industries whose exports form a small share of EUN exports to EU, CBAM is not likely to have major impact on overall GDP in EUN countries.

Figure 3.5. CBAM Analysis



Exports of Carbon-intensive goods to EU, 2021
(Percent of GDP)

Embodied Carbon Intensity in EU-27
(Embodied CO2 metric tons/$US million output)

Forgone revenue
(% of GDP)

Sectoral Share of Forgone Revenue
(CBAM USD$50, Domestic standards)

Sources: IMF staff calculations, Eurostat.
Notes: The CBAM analysis covers six carbon intensive sectors, including chemicals, metals, textiles, transport equipment, wood, and other EITE. *Domestic standard* refers to the estimation using carbon intensity of exporting countries (i.e., EUNs) and *country specific standard* refers to the estimation using carbon intensity of importing countries standard (i.e., EU-27).

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[12] Potential (foregone) revenue is the product of a country's imports (exports), the carbon intensity of the import (export) products, and the tax value of the CBAM.

IV. Carbon Tax and its Implications

The future course of EU's emissions mitigation policies is likely to be increasingly stringent and one where it redoubles efforts to preserve its economic competitiveness by aligning incentives of foreign producers who export to the bloc. The CBAM, in its current form which would be fully operational by 2026, is limited to select industries and would be phased in over the next few years and is thus not expected to have immediate impacts on EU's partner countries. But given its record, the EU could continue to broaden and tighten its emissions policies over the medium and long term, which in turn would mean economywide spillovers for EUN countries. In this section we discuss how the EUN countries could preemptively overcome these challenges by initiating unilateral decarbonization.

From an economic standpoint, unilaterally using an economywide carbon price is perhaps the most effective incentive to alter the behavior of firms and consumers to decarbonize. By imposing a tax on CO_2 emissions today that raises the price of carbon, the EUN countries could raise the price of carbon and thus transmit a powerful signal through their economies—a signal that would make carbon-intensive goods and services dearer, and therefore would help rebalance consumption and production toward low-carbon options. There would be the added benefit of decarbonizing exports faster and in a more comprehensive fashion than would happen through CBAM.

Despite its obvious pros, carbon tax comes with many real and perceived cons. First, is an overarching fear that there is a tradeoff between carbon taxation and output and employment—that a higher price of carbon will result in deindustrialization as many existing industries will not be able to adapt, resulting in worker layoffs. Second, policymakers fear that the change in pricing in the economy brought about by the carbon tax would hit consumers, particularly poorer ones. Third, there are real economic costs associated with economywide decarbonization in general, undertaken through measures such as carbon tax—these depend on the costs, availability, and implementation of alternative green technologies. Cost of energy generation have declined over time as renewable generation has become cheaper, but they remain much higher for economic activities without clear alternative green technologies (e.g. maritime and air transportation). Last, energy-related decarbonization also entail risks of stranded assets and relatively large employment transitions for specific activities and/or regions. These risks and transition costs also imply political economy concerns that can make carbon pricing politically unfeasible. A carbon tax is thus often perceived as an efficient instrument that is infeasible—i.e., it is difficult to sell as a viable policy option.

Macroeconomic Effects and Sectoral Distribution

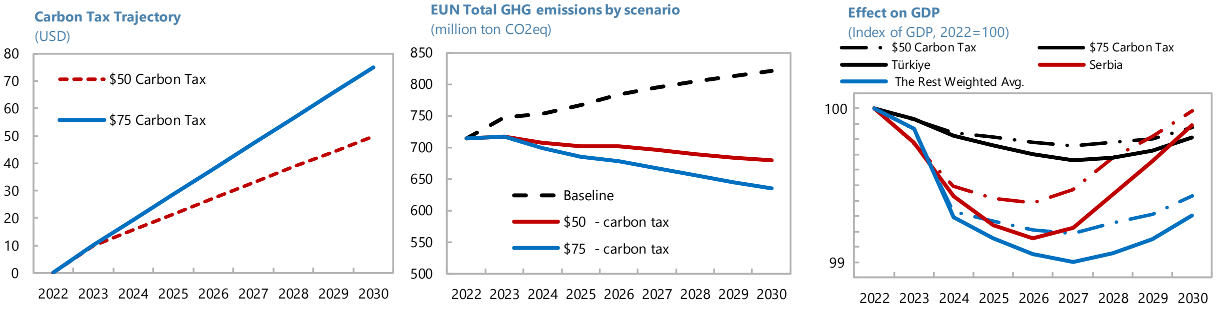
In this section we conduct an exercise whereby EUN countries unilaterally adopt a domestic carbon tax and use its receipts to allocate resources for growth enhancement and inequality reduction. Note that our carbon tax exercise described below is illustrative to show the impacts of such a tax, and is unrelated to the CBAM. We then assess the pros and cons of such a policy for overall output, firms, and households in each individual economy.

Carbon Tax Trajectory, Emissions, Output, and Fiscal Revenue

We employ the IMF's Climate Policy Assessment Tool (CPAT) to study the economic effects of a carbon tax on output, and of recycling the revenues for growth enhancement and compensation of affected households. By using carbon taxation as a pricing instrument, the CPAT approach can assess country-level effects on several economic variables—namely, energy demand, prices, emissions, fiscal revenues, GDP—as well as distributional consequences for household consumption.[13] However, it should be noted that the CPAT is a partial-equilibrium tool to assess domestic effects of a carbon tax without accounting for international spillovers (e.g., carbon leakage) or household income effects. Accordingly, other scenarios in which each EUN country acts alone or in a broader coalition can significantly affect the overall results.

- **We conduct two scenarios wherein EUN countries phase in, over time, two target rates of carbon taxes.** We assume a carbon tax of $10 per ton is introduced in 2023, and is gradually increased to reach either $50 per ton or $75 per ton by 2030. The higher carbon tax of $75 per ton would achieve greater reduction in emissions compared to the lower tax, but it could also have relatively larger growth dampening effect. The $75 per ton price of carbon is closer to the average EU carbon price in 2023 of about $86 per ton.[14]
- **Under the scenarios, we mitigate the negative economic and social consequences of carbon tax by ploughing back its revenues.** The recycling assumption allows the government to use the collected carbon taxation to reduce other economic inefficiencies and deficiencies. We assume that tax revenues generated by the carbon tax are recycled through the following set of compensatory policies: (i) a reduction in labor tax (15 percent of the additional collection); (ii) an increase in public investment (40 percent); (iii) an increase in current expenditures on education and healthcare (30 percent); and, not least, (iv) a higher allocation for targeted cash transfers (15 percent).[15] Depending on the implementation of the policy mix, the benefit could outweigh the costs over time.

- **Figure 4.1. Carbon Tax Effects on Emissions and GDP**



Source: CPAT and IMF Staff Calculations.

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[13] The CPAT model uses country-specific projections of income growth, fuel use and CO_2 emissions by the energy, industrial, transportation, and residential sectors, as well as projections on technological change and global energy prices (IMF, 2019a; Parry et. al., 2021). It is parameterized using country data and projections on fuel use by sector, real GDP, energy taxes, subsidies, prices by energy products. Assumptions for fuel price responsiveness are based on empirical evidence and results from energy models. The results show the relative impacts to the baseline where there are no introduction of new policies, and all existing policies stay the same. See Parry et. al., 2021for a detailed description of the methodology.

[14] The price of carbon emissions allowances (EUA) traded on EU's ETS was euro 85.2 per ton on December 1, 2022 and has averaged at $86 per ton in the year 2023 to August.

[15] Labor tax wedge—the difference between the total cost of labor to an employer and the amount of take-home pay received by the employee—is particularly high in most EUN countries (Jousten and others, 2022). The Western Balkan countries also suffer from an infrastructure gap, which in addition to requiring improvements in public investment management would also benefit from higher public investment spending ().

- **A unilateral carbon tax imposed in EUN countries would not result in much negative macroeconomic implications by 2030, but would yield considerable dampening of emissions (figure 4.1) relative to the business-as-usual (BAU) baseline.**[16]
    - With a $75 per ton carbon tax, the EUN region would reduce its CO_2 emissions by 2030 by about 25 percent compared to the business-as-usual level (about 11 percent lower by 2030 than the current level). To put EUN countries' self-declared NDC targets in context, we compare the envisaged emissions in 2030 under the NDC against the imposition of a $75 per ton carbon tax and find that a significantly higher carbon tax rate would be needed to meet the NDCs, except for Serbia (Figure 4.2).
    - With appropriate recycling of the $75 per ton carbon tax revenues, there would be minor impact on GDP by 2030 relative to the BAU baseline. Following a small dip in output that would not exceed 1 percent of 2023 GDP, output would almost recover to 2023 level by 2030 for Serbia and Türkiye, and would be less than 1 ppt of GDP lower for the rest.
    - Average fiscal revenue would be about 3 percentage points of GDP higher relative to a BAU baseline under a $75 carbon tax, with Albania and Türkiye showing particularly small revenue impact of below 2 percent of GDP (figure 4.2). Overall, carbon tax revenues and their recycling could positively contribute to the environmental goals of the region in both the short and long run. However, the specific impact would depend on the production and redistribution systems of each country.
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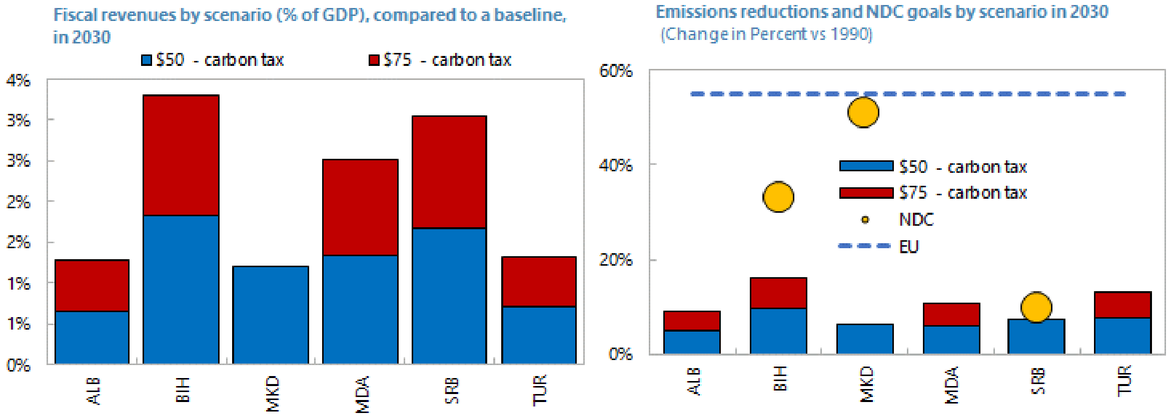
Figure 4.2. Carbon Tax Revenue and Emissions Targets

Fiscal revenues by scenario (% of GDP), compared to a baseline, in 2030

Emissions reductions and NDC goals by scenario in 2030 (Change in Percent vs 1990)



Source: CPAT, Climate Watch, Potsdam Institute for Climate Impact Research and IMF Staff Calculation.
Note: 1/The NDC goals used in CPAT refers to average NDC for both conditional target and unconditional target.
2/ The NDC data is missing for Kosovo and Montenegro.
3/ For $75 scenario, the data for MKD and SRB is missing.

Sectoral Implications: Direct and Indirect Effects

- **We analyze two channels of how higher carbon price would affect sectors—direct impacts through an increase in energy costs and indirect effects through increases in costs of inputs**. The direct

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[16] CPAT is a single country tool and does not account for spillovers from the actions of other countries (i.e., if other countries choose to implement or not). In addition, the BAU baseline assumes that there are no introduction of new policies and all existing policies in place. The analysis also uses the latest WEO forecast for the outer years.

impact of the carbon tax on energy costs will depend on the carbon content of the fuels used to generate energy and the burden will be greater on firms that use coal-fired power than for those that rely on cleaner fuels. Figure 4.3 provides a sector-by-sector summary of how a $75 per ton carbon tax will affect the direct cost of energy inputs in the five most affected industries (based on data availability). The increase in such input costs would be particularly high, by about 15 percent or more, in chemicals, non-metallic minerals (Serbia and Albania) and basic metals (Albania).

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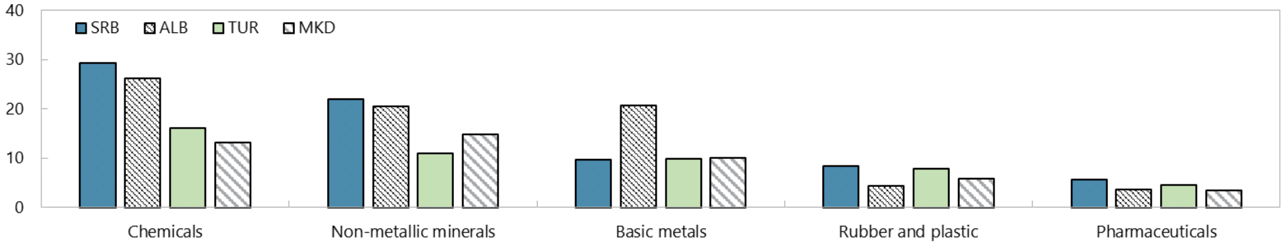
Figure 4.3.Impact of Carbon Tax on Energy Inputs Cost

(percent of total costs)



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Note: Carbon tax at $75 per tCO2e

The carbon tax will also affect firms indirectly as higher energy prices push up upstream costs of inputs. Using data on the energy intensity of production and input-output (I/O) tables, we estimate the direct and indirect effects on costs of a $75 per ton carbon tax in selected EUN countries.[17] Serbia stands out as the country where the increase in input costs will be the highest—exceeding 10 percent in 5 of the most affected industries, while North Macedonia and Türkiye will see relatively milder input cost increases (mostly below 15 percent; Figure 4.4). The sectoral distribution of the impact of carbon tax is similar across the countries analyzed. While the direct burden is the highest in the chemical and non-metallic minerals (mainly cement), and industries, the indirect effects are relatively more significant in production of rubber and plastics, transport equipment, wood and paper, accounting for almost half of the price increase. Therefore, carbon pricing can be reinforced by sectoral instruments (ideally price-based and revenue neutral tools). In addition, revenue recycling could target the EITE industries to avoid near term output losses, such as through rebates that are proportional to output (or an ETS with free allowances) and potentially be phased out over time,

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● **Figure 4.4. Impact of Carbon Tax on Inputs Cost**

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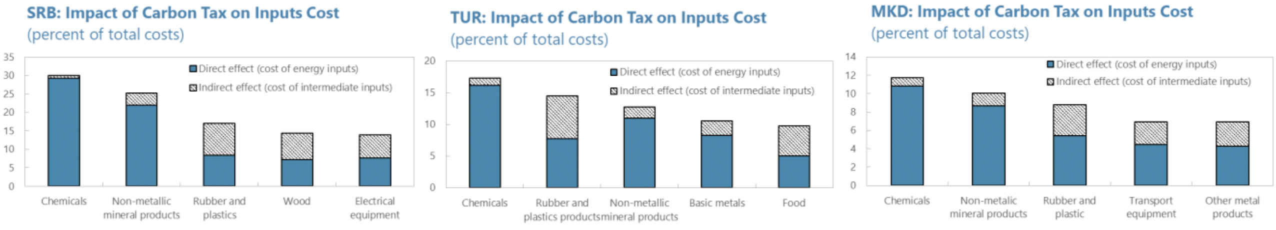

SRB: Impact of Carbon Tax on Inputs Cost
(percent of total costs)

TUR: Impact of Carbon Tax on Inputs Cost
(percent of total costs)

MKD: Impact of Carbon Tax on Inputs Cost
(percent of total costs)

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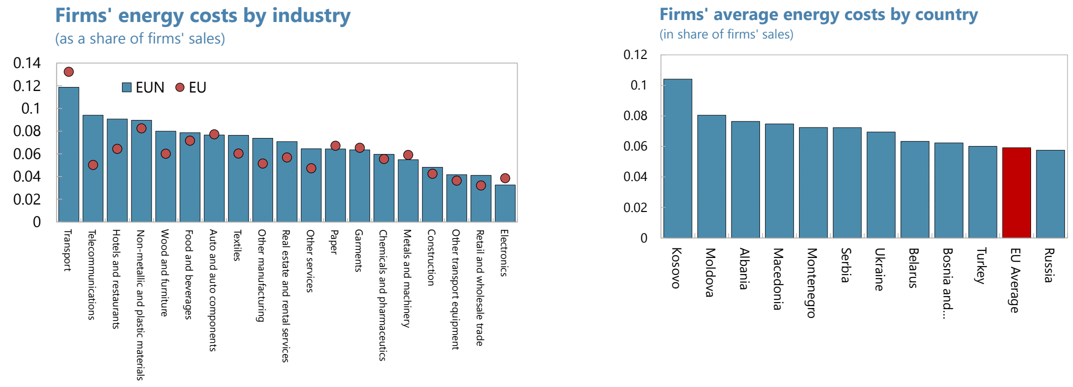
[17] The analysis assumes full pass-through of the cost increase throughout the supply chain.

Firm-Level Impacts

We analyze the impacts of a carbon tax on firms by focusing on energy dependency. Firms that have high energy costs relative to total sales could face competitive pressures and may even be forced to exit in the face of rising price of carbon. Firms in EUN countries tend to have higher energy costs relative to sales than those in the EU (Figure 4.5). Industries such as mining and quarrying in Albania, other manufacturing in North Macedonia and Kosovo, chemicals and pharmaceuticals in Moldova and Montenegro, and textiles and garments in Serbia would face significant costs pressure following the implementation of carbon taxation (Table 4.1).

Figure 4.5. Firm Energy Cost by Industry and by Country



Source: EBS Survey.

Table 4.1. Energy Dependency of Different Industries in EU Neighborhood Countries

(Weighted Average firm-level energy expenses out of total costs, share)

	Albania	Bosnia and Herzegovina	Macedonia	Kosovo	Moldova	Montenegro	Serbia	Turkey	Ukraine	EU Average
Chemicals and pharmaceutics	0.11	0.03	0.03	0.15	0.28	0.23	0.06	0.06	0.04	0.06
Construction	0.04	0.04	0.02		0.09		0.03	0.08	0.05	0.04
Electronics		0.01	0.03	0.15	0.00		0.03	0.03	0.04	0.04
Food and beverages	0.07	0.07	0.08	0.11	0.11	0.11	0.07	0.07	0.10	0.07
Garments	0.06	0.06	0.06		0.07		0.21	0.04	0.08	0.07
Hotels and restaurants	0.09	0.09	0.11		0.08		0.09	0.09	0.07	0.06
Leather	0.04	0.04	0.03	0.08	0.06	0.01	0.04	0.04	0.12	0.09
Metals and machinery	0.06	0.06	0.06	0.10	0.07	0.03	0.06	0.05	0.06	0.06
Mining and quarrying	0.22	0.10	0.02				0.05			0.10
Non-metallic and plastic materials	0.13	0.10	0.15	0.10	0.05	0.09	0.09	0.09	0.06	0.08
Other services	0.09	0.06	0.04		0.05		0.05	0.11	0.08	0.05
Transport equipment		0.07	0.09	0.16	0.00	0.01	0.12	0.07	0.23	0.06
Paper	0.04	0.07	0.09	0.04		0.00	0.06	0.09	0.08	0.07
Real estate and rental services		0.13	0.14				0.01	0.03	0.09	0.06
Retail and wholesale trade	0.05	0.03	0.05	0.13	0.04		0.06	0.04	0.04	0.03
Telecommunications		0.02			0.06			0.13	0.09	0.05
Textiles		0.05	0.18	0.02	0.11	0.02	0.24	0.07	0.06	0.06
Transport	0.11	0.08	0.14		0.08		0.11	0.10	0.07	0.13
Wood and furniture	0.11	0.08	0.07	0.08	0.08	0.05	0.10	0.06	0.10	0.06
Other manufacturing	0.08	0.05	0.26	0.27	0.05		0.04	0.04	0.08	0.05
Total Manufacturing	**0.08**	**0.06**	**0.07**	**0.10**	**0.08**	**0.07**	**0.07**	**0.06**	**0.07**	**0.06**

Source: IMF staff estimate

The results of our econometric analysis suggest that the implementation of a carbon tax will have a disproportionate impact on smaller, older, less productive, labor-intensive, and domestically focused firms because of their higher energy dependence. We regress energy dependence, measured as the ratio of energy costs to total sales on key independent variables. The sample comprises 21,000 firms in 12 industries in the EUN region.

- Firms that exhibit high productivity would be less affected by carbon taxation, as they are less energy dependent. Our econometric analysis reveals that a 10 percent increase in labor productivity is associated with lower energy dependence of 4 percent (Figures 4.2 and 4.6; also see detailed results in Annex 1).
- Small and medium-sized enterprises predominate in the EUN countries—particularly in the Western Balkans—and such firms could be disproportionately affected by carbon taxation, primarily because they spend a greater share of their costs on energy. In contrast, larger firms may benefit from a scale effect on energy consumption—our analysis reveals that an increase in the number of employees by 100 is associated with lower energy dependence of 1 percent of total cost. The finding has significant implications for offsetting the effects of carbon tax policy, as up to 99 percent of all enterprises in the region are classified as small or medium-sized (WB EDIF). If carbon taxation were to be implemented, smaller firms would be disproportionately affected, with potential job losses.
- Firms engaged in exports should be less affected by carbon taxation than their counterparts who do not. Our results show that a EUN firm that exports some of its production could be 27 percent less affected by the higher energy costs than a firm that supplies solely to the domestic market. Non-export-oriented firms have high energy dependence, and thus, are more vulnerable to carbon taxation. We also find that industries with the greatest vulnerability are those in primary product and service sectors, such as mining and quarrying, hotels and restaurants, and food and beverages.
- Lastly, energy dependency is positively associated with the age of the firms suggesting that younger firms may also be more energy efficient and thus less vulnerable to carbon tax impacts.

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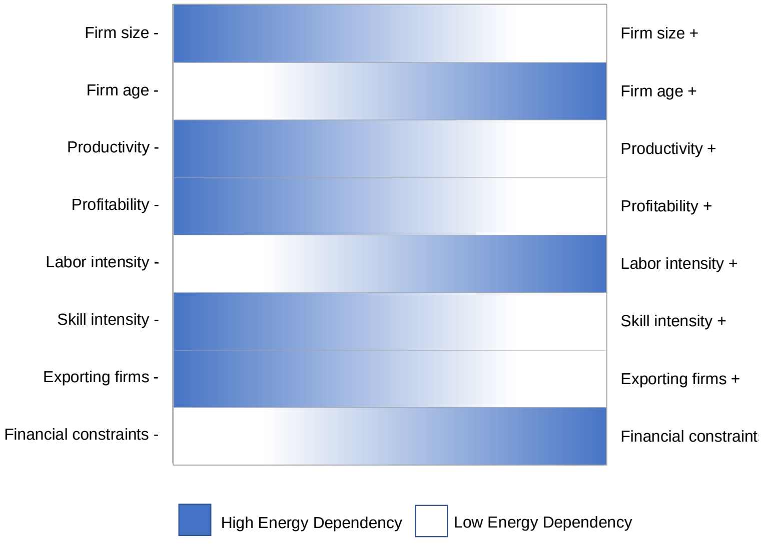
Table 4.2. Firm Level Determinants of Energy Dependency

Variable	Coeffcient	
Employees (log)	-0.11	***
	(0.01)	
Age (log)	0.01	***
	(0.02)	
Productivity	-0.32	***
	(0.04)	
Profitability	-0.16	***
	(0.03)	
Labor intensity	0.48	***
	(0.02)	
Skill intensity	-0.14	***
	(0.03)	
Exporting	-0.24	***
	(0.04)	
Constraints to financial access	0.04	***
	(0.01)	

Note: Results are obtained from fixed-effects regressions controlling for differences in industry an country characteristics.
*** indicates a significance level above 10 percent.
Dependent variable: Ratio of energy cost to total sale.

Figure 4.6. Energy Dependency by Different Firm Characteristics



Sources: World Bank Enterprise Survey and author's calculations.
Note: The difference in coefficient is significant at least at the 10 percent significance level
Results are obtained from fixed-effects regressions controlling for differences in industry ar country characteristics.

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Household-Level Impact

Among the main political economy barriers to the adoption of carbon pricing reform is the concern about its impact on household consumption and income inequality. It is argued that an economy-wide carbon tax could reduce household consumption and since poorer households are more reliant on energy as a share of their overall consumption, it could also affect the most vulnerable in society, particularly, if no mitigating measures are implemented.[18] Therefore, policymakers need to address the distributional impact of carbon pricing reforms by designing compensatory measures, including means-tested cash transfer and social assistance programs, to protect the most vulnerable segments of the population.

We employ the CPAT to simulate the distributional impact of a carbon tax on households in EUN countries. We present the CPAT assessment for Serbia and Türkiye—two countries that have comprehensive household expenditure surveys available. For the baseline (pre-tax) estimation, we assume, consistent with the macro-level exercise above, that a carbon tax is imposed in 2023 and is gradually increased to $75 per ton of CO_2 emissions by 2030.[19] We study the extent to which a new carbon tax would reduce household consumption, both directly, through higher energy prices, and indirectly, through higher costs embedded in other goods and services. Furthermore, we also assess if poorer households, who are thought to consume a high level of energy as share of total consumption, would be more impacted by price changes than wealthier households.

An important part of the CPAT exercise is to choose the appropriate assumptions about recycling carbon tax revenues. Since public acceptability of climate-related fiscal reforms is key to successful implementation, the perceived fairness of these policies depends on how additional revenues are recycled to compensate vulnerable households. For example, in developing countries where informal sector is common, lowering the income tax rate would not benefit the poorest and most vulnerable. On the other hand, increasing public investment (especially on improving energy infrastructure and expanding renewable sources of energy), current expenditures on education and healthcare, and targeted direct transfers would be more effective in protecting the vulnerable segments while boosting growth. We follow the same recycling assumption as the one conducted in the exercise above.[20] It is important to note that in our exercise the distributional impact of a carbon tax on households is based solely on consumption effects through changes in prices; we do not consider the impact on household income through changes in wages and employment levels.

In the absence of revenue recycling, a carbon tax of $75 per ton would cause a small and distributionally-neutral reduction in household consumption—by about 2½ to 3 percent in Türkiye and Serbia, respectively. The calculation is based on both direct effect, through higher energy prices, and indirect effect, through higher embedded costs of other goods and services (Figure 4.7). There is little evidence that the carbon tax would be regressive as the drop in household consumption is largely *uniform* across the distribution of households. The result is consistent with that found in other middle-income economies where the share of energy in household consumption does not vary much by consumption level (Dorband and others,

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[18] On the redistributive effects of carbon taxation see Metcalf (2009), Rentschler and Bazilian (2017), Klenert and others (2018), Carattini, Kallbekken, and Orlov (2019), and Shang (2021).

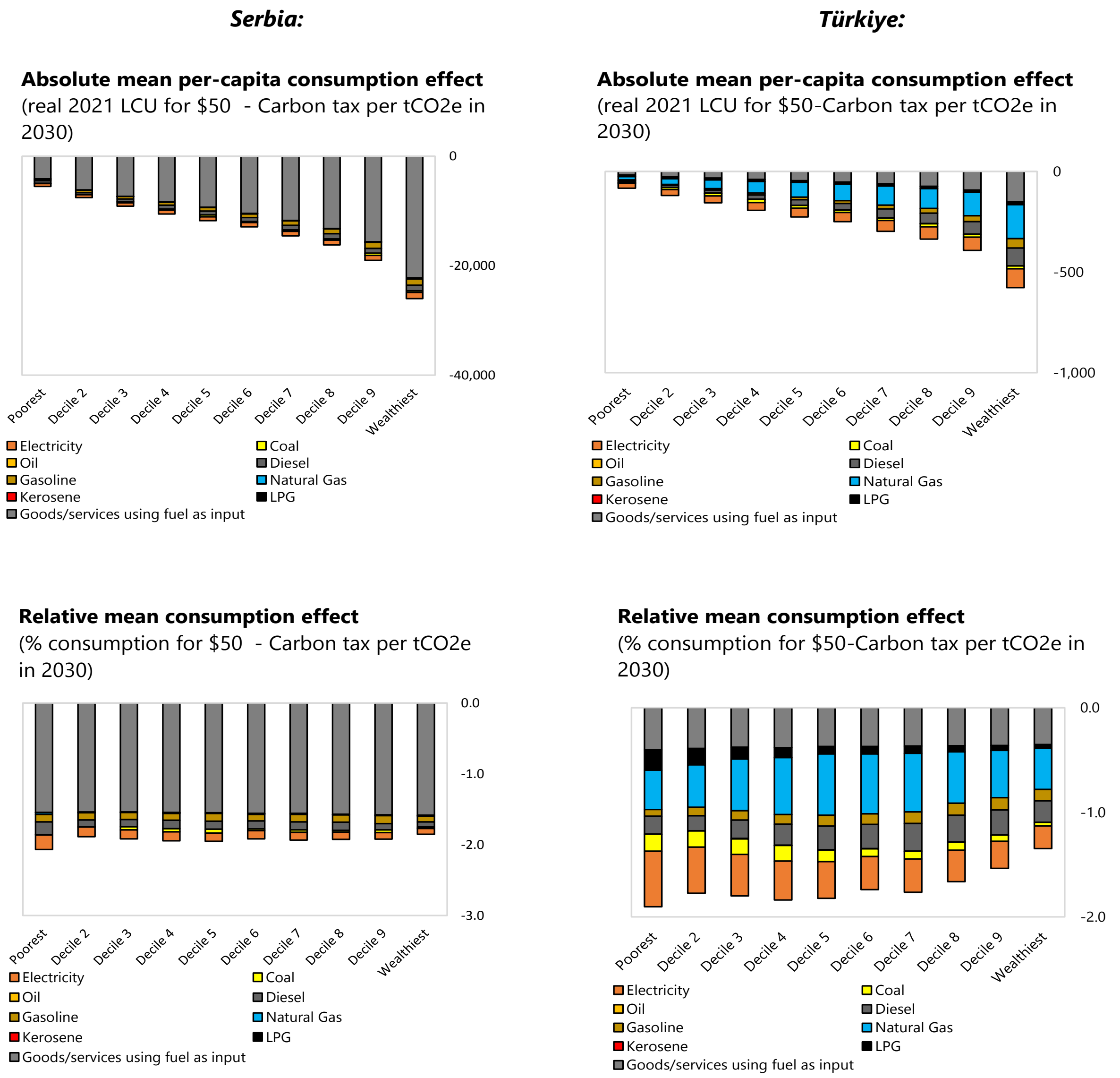
[19] The simulation analysis does not factor in spillovers from one country adopting a carbon tax into other countries. The model also assumes a carbon tax on fossil fuel products to be the only policy instrument used to mitigate climate change.

[20] Carbon tax is recycled through the following set of compensatory policies: (i) a reduction in labor tax (15 percent of the additional collection); (ii) an increase in public investment (40 percent); (iii) an increase in current expenditures on education and healthcare (30 percent); and (iv) a higher allocation for targeted cash transfers (15 percent).

2019; Ohlendorf and others, 2021). It is worth noting that the reduction in consumption would be slightly larger in rural than in urban households in Serbia.

Revenue recycling into productive spending and reduction in labor tax distortion yields an improvement in consumption across the distribution of household, and a progressive one at that. Revenue recycling would provide a significant boost to real GDP growth and household consumption, through the increase in public investment and higher current spending on health and education. Even before transfers, the recycling provides significant inequality reducing impact, with the lower deciles benefiting progressively more than high ones. The compensating transfer to the poor households (bottom four deciles), adds to the boost in household consumption even further. These findings are consistent with other climate mitigation policy studies that confirm the importance of policy design to protect the most vulnerable segments of the society during the green transition (WEO, 2022).

Figure 4.7. Distributional Impacts of Carbon-taxation and Recycling of Revenue



Serbia:

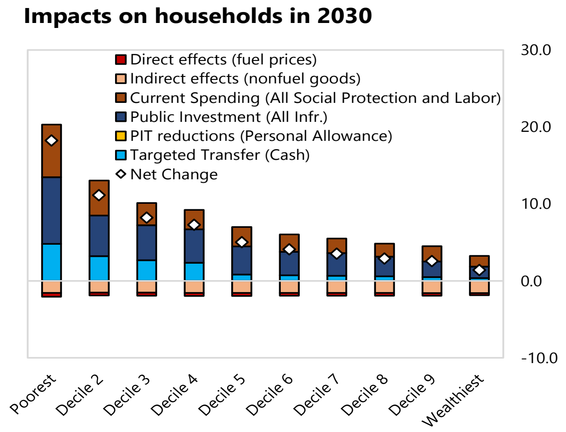
Türkiye:

Absolute mean per-capita consumption effect (real 2021 LCU for $50 - Carbon tax per tCO2e in 2030)

Absolute mean per-capita consumption effect (real 2021 LCU for $50-Carbon tax per tCO2e in 2030)

Relative mean consumption effect (% consumption for $50 - Carbon tax per tCO2e in 2030)

Relative mean consumption effect (% consumption for $50-Carbon tax per tCO2e in 2030)



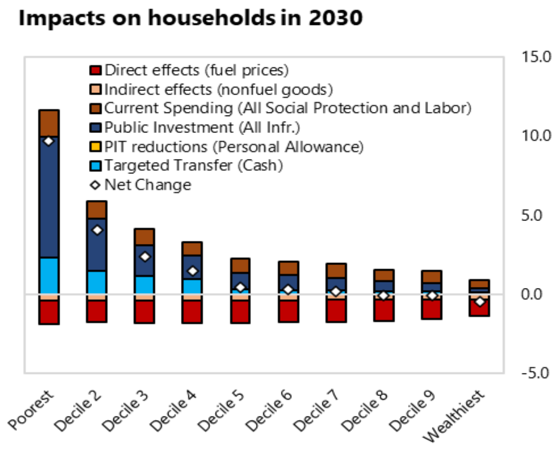
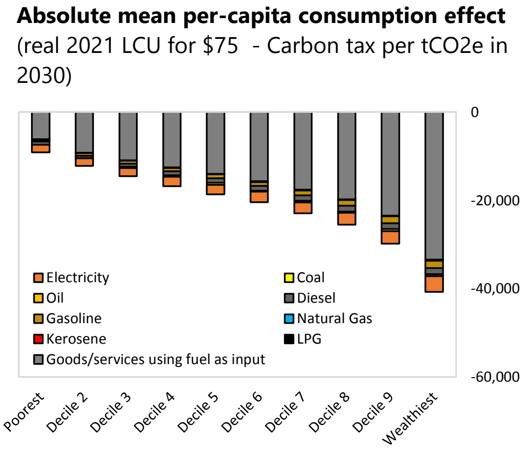
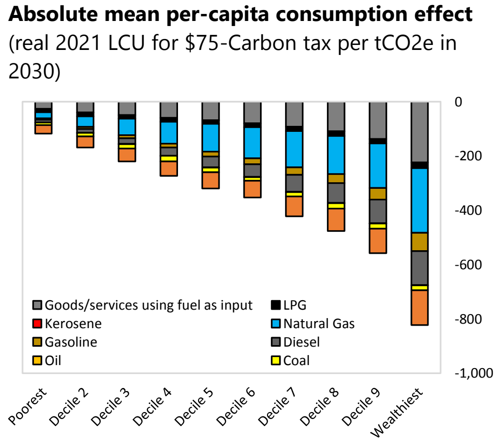


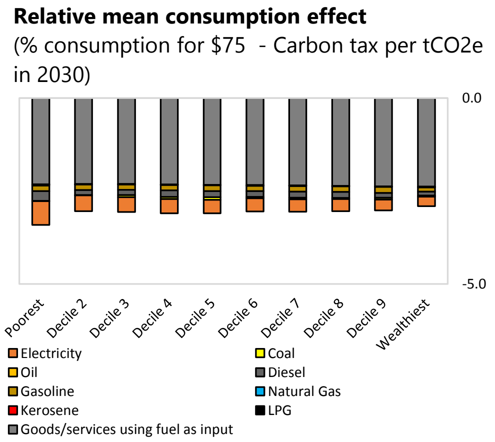
Figure 4.8. Distributional Impacts of Carbon-taxation and Recycling of Revenues

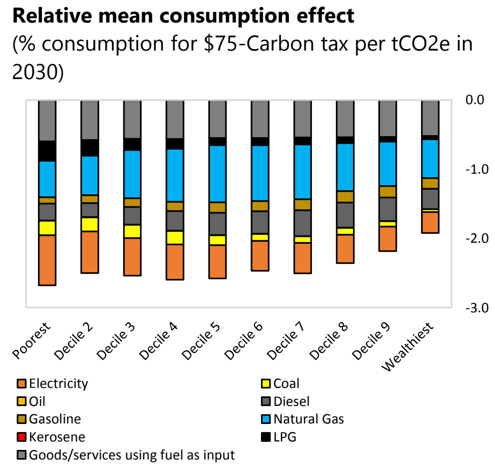
Serbia:

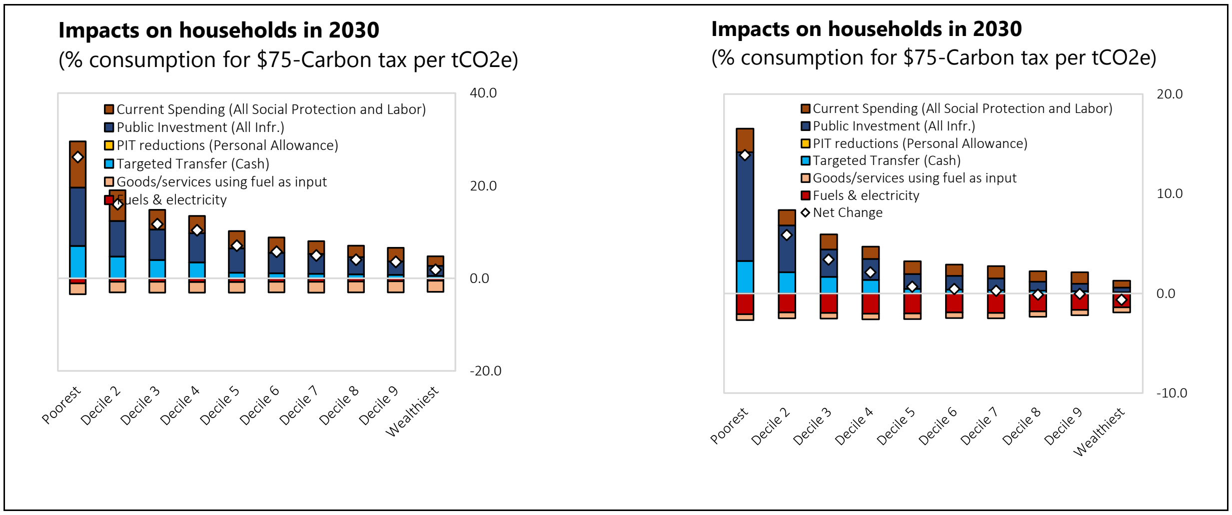
Türkiye:











V. Policy Lessons and Implications

The paper assesses where the EUN countries stand today on carbon emissions mitigation and policies associated with it; how climate change mitigation policies of the EU spillover to the EU neighborhood; and, if such spillovers are indeed large, then how should the EUN countries respond.

The emission problem in the EUN countries arises, in large part, from their carbon-intense power generation and industrial sectors. The high natural endowment of coal in EUN countries may have been a major source of locally available energy in the past, and it may have served these countries well during the energy price shocks emanating from the Russian invasion of Ukraine, but in a world that is increasingly likely to internalize carbon costs, coal will quickly become a “costly” fuel. The power sector, which is the main user of coal and is also a major contributor to emissions, affects the carbon footprint of downstream economic activities.

EUN countries’ record on emissions mitigation policies is generally weak. Despite making some progress in introducing emission reduction policies since 2000, they have significantly lagged EU members in this regard. EUN countries have been moving only gradually towards market-based instruments over this period. Also, explicit fossil fuel subsidies in EUN countries today are substantial, and as a group, they compare unfavorably in terms of implicit subsidies, i.e., the cost of fossil fuel externalities not covered by consumer prices.

Our empirical analysis finds evidence of favorable spillover of ever tightening emissions mitigation policies in the EU on emissions in EUN countries. The increasing stringency of climate policies in the EU over the past two decades appear to have spilled over considerably. We find a negative association over time between the stringency of emissions mitigation policies in EU and emissions in EUN countries, and the fact that the relationship is significantly more pronounced than for other EMs elsewhere, implies that EUN countries tend to lower their emissions in response to tightening EU mitigation policies.

Our analysis of the impacts of carbon border adjustment mechanism (CBAM) finds that while its effects on output may be limited, it would have sizable spillovers on exports and certain sectors. EUN policymakers are faced with the question of how much impact it will have on their countries in the coming years as well as in the more distant future when the policy is expected to be tightened further by expanding it to a wider set of the Union’s imports.[21] Output effects of the CBAM once it is fully operationalized in 2026 would be limited. However, exports of EUN countries’ emissions-intensive industries would be directly affected, particularly metals and energy industries, and North Macedonia and Serbia are particularly heavily exposed in this regard. Over the next decade, the EU ETS emissions cap for power and industry is set to converge to zero by 2040 and an ETS on emissions for buildings and transport is envisioned; these future developments could have spillover effects for EUN countries, though these countries have less of a catch up to do in the latter sectors. In addition, over the long run, further tightening of the CBAM could also affect the competitiveness of EUN countries given their trade integration with the EU, necessitating the tightening of emission mitigation policies.

Putting a price on carbon is the most economically efficient and equitable policy response to the emerging challenge of decarbonization in EUN. By reflecting the cost of emissions in the prices of fuels, electricity, and goods, carbon pricing would promote a full range of behavioral responses across households, firms, and sectors for reducing energy use and shifting toward cleaner energy sources. Our findings suggest that the fear that a tax on carbon may adversely affect output by hitting firms and reducing household welfare, particularly for the poorer ones, is overdone. At the same time, it is important to underscore that policymakers need to be mindful of the industries that could be hit hard by a decarbonization policy—namely, coal mining, power generation, and other carbon intensive industries. A policy action that includes social assistance and technical retraining of workers in such industries would be desirable.

Market instruments other than a carbon tax and non-market instruments can also be viable policy options. Putting a price on carbon through the introduction of carbon tax is a first best policy, but it has also been a reform that has elicited concerns and has been unacceptable, not least in middle income countries where it is viewed by the public as an unnecessary price to pay for the past pollution of developed countries. Not surprisingly, EUN countries have tended to focus on non-market instruments to mitigate emissions—mainly, standards and regulations. Indeed, in the period ahead, they may choose to persist with such instruments, and tighten them to achieve their climate objectives. Even when considering market instruments, they may use a “coal tax” that is likely to be less politically contentious than an explicit carbon tax. One area where there may be easy gains is energy efficiency. Actively striving to improve energy efficiency in commercial and residential use may yield as much in lowering emissions as shifting the energy matrix away from fossil fuels.

The EUN countries are at different stages on the path to EU accession and alignment with EU climate policy is inevitable. Ultimate entry into the EU would require realigning the economy with EU’s climate goals and its standards on emissions—a direct channel of spillover of EU policies. In this regard, policymakers in these countries face a choice: whether to wait to transition their economies away from carbon later when it is necessary to do so for EU accessions reasons, or to do so as soon as possible.

The EUN countries could postpone decarbonization till later but that may not be ideal for them. The EUN economies we have considered in the paper are middle income ones that have not been major GHG emitters in the past. They are, therefore, eligible for consideration under the Paris Agreement’s relatively lenient treatment on emissions—i.e., differentiated responsibilities. They could certainly choose to proceed at a slow pace on the path of emissions mitigation. However, the findings in this paper suggest that delaying action is not the best strategy for these countries.

An early adoption of a comprehensive decarbonization strategy, such as through the introduction of an economywide carbon tax, would be of greater benefit for these countries than postponing it for later. Given their geographical proximity to the EU, strong trade and FDI linkages, a history of favorable spillovers

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[21] See for instance, paragraph 26 in Council of Europe (2022)

from tightening of climate policies in EU, and the fact that most of the EUN countries are on the path of EU accession, which among other things, would require an alignment with EU emissions standards, it would be in the interest of the EUN economies to keep pace with the speed of emission mitigation in the EU in future. First, front-loading of decarbonization would result in a restructuring of the economy that would make the exports of these countries broadly compliant with standards and carbon content in EU importing countries and allow for an export-led growth and convergence, including through greater potential for joining global value chains linked to the EU. Second, the flows of green FDI and technology from the EU can underpin the carbon transition in these countries and the sooner that happens the earlier EUN are likely to ease their infrastructure and investment shortfalls and get on a path of faster economic convergence with the EU. Other complementary reforms of the business climate and leveling of the playing field between resident and non-resident investors would also help in this regard (Ilahi and others, 2019). In tandem, as a precursor to eventually joining the EU ETS, the EUN countries aspiring to membership could also set up a regional ETS, which could eventually merge with that in the EU. Last, early decarbonization will help these countries escape the impacts of any disorderly adjustment associated with the operationalization of CBAM.

Annex 1. Methodology: Firm-Level Analysis

To comprehend the impact of carbon taxation on firms, a firm-level analysis was conducted using the World Bank Enterprise Survey (WBES). The WBES represents a comprehensive examination of the private sector through random stratified sampling of a representative sample of an economy, with a vast array of economic data collected from 171,000 firms across 149 countries. The survey encompasses a broad spectrum of business environment themes, including access to finance, corruption, infrastructure, crime, competition, and performance indicators.

To analyze the impact of climate-related policies on firms within the European Union's immediate neighborhood, a dataset was selected from the World Bank Enterprise Survey (WBES) database covering 11 countries, including Albania, Bosnia and Herzegovina, Kosovo, Moldova, North Macedonia, Montenegro, Serbia, Türkiye, and Ukraine. The selected dataset spans from 2002 to 2013, incorporating 21,793 observations and comprising 12 industry categories, including construction, electricity, gas, and water supply, financial intermediation, health and social work, hotels and restaurants, manufacturing, mining and quarrying, other community, social, and personal service activities, public administration, real estate, transport, storage, and communications, wholesale and retail trade; repair of motor vehicles and motorcycles.

The data collection cycle for the 11 sample countries was conducted at different intervals. In some cases, the survey was conducted one year ahead. The World Bank Enterprise Survey was initiated in 2002, but the analysis in this study is based on data collected from 2002 to 2013. Prior to 2006, the questionnaire structure differed significantly, and efforts are needed to make the conversion, while subsequent to 2019, the focus of the survey shifted to investigating the impact of the COVID-19 pandemic.

To quantitatively assess the potential impact of carbon taxation on firms, the impact was defined as the energy cost relative to the total sales of each individual firm. An alternative approach would have been to calculate the energy cost relative to the production cost. However, only approximately 11,000 observations were available using the production cost method, hence the sales approach was employed in the analysis in order to encompass a broader coverage.

In our analysis, we also evaluated the varying impacts of carbon taxation on firms with distinct characteristics, including firm profitability, firm size, firm age, labor productivity, export activities, factor intensity, and financial constraints. Firm profitability was calculated as the difference between sales and production costs. Firm size was determined by the number of employees, with firms having less than 20 employees classified as small, those with more than 20 employees but less than 100 classified as medium, and those with more than 100 employees classified as large. Firm age was determined by subtracting the established year from the current year. Labor productivity was calculated as the ratio of the difference between sales and material cost to the number of employees, and reflected the value contributed by a single employee. Firms engaged in exporting activities were captured by the export share in their sales. The factor intensity was comprised of labor

Sample Description: EU Neighbourhood Countries

# of firms Observations	2002	2003	2005	2007	2008	2009	2012	2013	Total
Albania	170		204	304		175		360	1213
Bosnia and Herzegovina	182		200			349		360	1091
Belarus	250		325		272			360	1207
Kosovo						270		202	472
Moldova	174	103	350			362		360	1349
Macedonia, FYR	170		200			342		360	1072
Montenegro, Rep. of	250	100	300			115		150	915
Russia	506		601			997	4214		6318
Serbia	250	408	300			386		360	1704
Turkey	514		557		1127			1344	3542
Ukraine	463		594		851			1002	2910

intensity and skill intensity, with labor intensity calculated as the ratio of total labor cost to sales, and skill intensity calculated as the ratio of total labor cost to the number of employees. Financial constraints were identified through a dummy variable, defined as firms answering affirmatively to facing constraints on interest rates, fees, or collateral.

We conducted a fixed-effect regression analysis to estimate the firm-level energy expenses as a proportion of total costs, with respect to all of the identified characteristics.

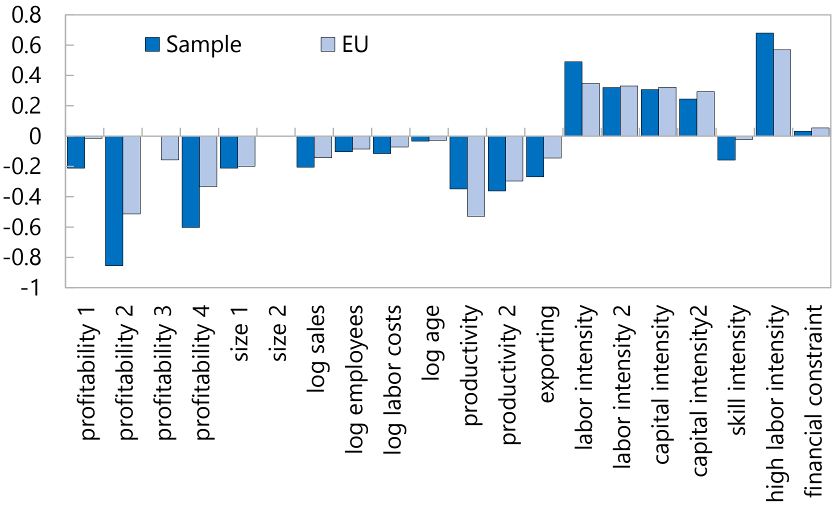
$$\text{In}\ (energydependency_{ijct}) = \alpha + \beta \times keyvar_{ijct} + industry_j + country_c + year_t + \varepsilon_{ijct}$$

In this regression model, *i* represents the individual firm within industry *j* located in country *c* during year *t*. The country fixed effects $country_c$ control for all time-invariant macroeconomic conditions specific to the country. The time fixed effects $year_t$ control for global business cycles as the survey was conducted at different points in time. The industry fixed effects $industry_j$ control for industry-specific factors in the impact of carbon taxation. The coefficient β represents the impact of a specific firm characteristic on the firm's energy dependency within the context of carbon taxation.

Our results were found to be robust under alternative identification approaches for each firm characteristic. For firm profitability, the results were consistent regardless of whether we used dummy variables for high profitability, profitability ratios, or the natural log of profit. For firm size, the results were significant whether we used a categorized firm size dummy variable or a continuous measure of the number of employees. The results for firm age were also robust using either a continuous measure or the natural log of age. For labor productivity, the results were robust using both the measure of sales divided by the number of employees, and the measure of sales excluding material cost divided by the number of employees. The same was found to be true for labor intensity, which maintained robustness using either the measure of total labor cost divided by the number of employees or total labor cost excluding material cost divided by the number of employees. In conclusion, the results were robust with alternative methods for identifying firm characteristics, and with the addition of control variables in the specific regression models.

Robustness Comparison

(Coefficient with at least 10% statistical significance)



Sources: IMF Staff Calculation.

Note: Profitability 1,2,3,4 is profit, dummy variables for high profitability, the natural log of profit profitability ratios and profitability ratios accordingly. Size 1,2 is a categorized firm size dummy variable and a continuous measure of the number of employees. Labor productivity1,2 is the measure of sales divided by the number of employees, and the measure of sales excluding material cost divided by the number of employees. Labor intensity 1,2 is the measure of total labor cost divided by the number of employees and total labor cost excluding material cost divided by the number of employees.

Annex 2. Methodology: Energy Efficiency Analysis

Following Narayan and Narayan (2010), Özbuğday and Erbaş (2015) and Cevik (2022a; 2022b; 2023), the econometric model used to analyze the impact of energy efficiency on CO_2 emissions takes the following form in a panel setting:

$$y_{i,t} = \beta_1 + \beta_2 EE_{i,t} + \beta_3 X_{i,t} + \eta_i + \mu_t + \varepsilon_{i,t}$$

where $y_{i,t}$ denotes the logarithm of CO_2 emissions per capita in country i and time t; $EE_{i,t}$ is energy efficiency as measured by the logarithm of energy consumption per unit of real GDP; $X_{i,t}$ is a vector of control variables including the logarithm of real GDP per capita, trade openness, share of industry in GDP, population, share of urban population, and a measure of institutional quality. As above, the η_i and μ_t coefficients denote the time-invariant country-specific effects and the time effects controlling for common shocks that may affect CO_2 emissions across all countries in a given year, respectively. $\varepsilon_{i,t}$ is the error term. To account for possible heteroskedasticity, robust standard errors are clustered at the country level.

Environmental outcomes are measured in terms of CO_2 emissions in metric tons per capita, which represent more than 80 percent of GHG emissions in Europe. The main explanatory variable of interests are energy efficiency as measured by energy consumption per unit of real GDP and the share of nuclear, renewable and other non-hydrocarbon sources of energy, which show considerable heterogeneity across countries and over time. The empirical analysis also includes a variety of economic, demographic and institutional variables to control for conventional factors affecting environmental outcomes.

The data series is taken from the IMF’s International Financial Statistics and World Economic Outlook databases, the World Bank’s World Development Indicators database, the U.S. Energy Information Administration, and the International Country Risk Guide.

Annex 3. Climate Policy Database

The Climate Policy Database serves as a vital resource for our report, featuring the latest dataset released in May 2022, encompassing a staggering 5783 policies from 198 countries. Maintained by the New Climate Institute with support from PBL Netherlands Environmental Assessment Agency and Wageningen University and Research, this database aims to gather information on climate mitigation policies and benchmark them against a comprehensive policy matrix. The policy database covers national mitigation-related policies and is updated periodically, providing us with the latest information on climate policies worldwide.

To analyze the evolution of climate policy adoption, the Climate Policy Database created a Policy Matrix that consists of 50 policy options distributed across six sectors and five mitigation areas. This matrix also incorporates eight policy instruments, which are essential for bridging the gap between policy objectives and their actual implementation (Rogge and Reichardt, 2016). The eight policy instruments, which include economic instruments, regulatory instruments, information and education, policy support, research, development and deployment (RDD), voluntary approaches, climate strategy and target, serve as the primary categories analyzed in this report, as Table** below.

In Climate Policy Database, policies are identified and combined with various policy instruments to constitute a comprehensive global mitigation package. The policies included in this database are selected based on their potential to contribute to emissions reductions as generally agreed by experts (IPCC, 2014), sector-level example policies that have been successful in specific contexts (UNFCCC, 2018; UNEP, 2019), or policies that are expected to lead to sufficient sectoral transformation to achieve emissions reductions (Mitchell et al., 2011; GEA, 2012; OECD/IEA and IRENA, 2017; IEA, 2018, 2019).

Table Annex 3.

Category	Sub-category	Policyinstrument
Economic instruments	Direct investment	Funds to sub-national governments
		Infrastructure investments
		Procurement rules
		RD&D funding
	Fiscal or financial incentives	CO2 taxes
		Energy and other taxes
		Feed-in tariffs or premiums
		Grants and subsidies
		Loans
		Net metering
		Tax relief
		User changes
		Tendering schemes
		Retirement premium
		User charges
	Market- based instruments	GHG emissions allowances
		GHG emission reduction crediting and offsettingmechanism
		Greencertificates
		White certificates
Regulatory instruments	Codes and standards	Building codesand standards
		Industrial air pollutionstandards
		Product Standards
		SectoralStandards
		Vehicle air pollution standards
		Vehicle fuel- economy and emissionsstandards
		Auditing
		Monitoring
		Obligation schemes
		Other mandatoryrequirements
Information and education	Performance label	Comparison label
		Endorsement label
		Advice and Aid inimplementation
		Information provision
		Professional training andqualification
Policy support		Institutional creation
		Strategicplanning
RD&D (out)	Research programme	Technology deploymentand diffusion
		Technology development
		Demonstration project
Voluntary approaches		Negotiated agreements (public/privatesector)
		Public voluntaryschemes
		Unilateral commitments (private sector)
		Removal of fossil-fuelsubsidies
		Removal of split incentives
		Grid accessand priority for renewables
Climate strategy		Formal & legally bindingclimate strategy
		Political & non- binding climate strategy
		Coordinating body for climatestrategy
Target	Energy efficiency target	Formal & legally binding energyefficiency target

Source: Climate Policy Database Codebook 2022 Version

Annex 4. Spillover Analysis

Our empirical analysis focuses on examining the evidence of spillover effects arising from the increased stringency of climate policies in the European Union (EU) and its association with emissions reduction in European Neighborhood (EUN) countries. To evaluate the influence of EU's climate mitigation policies on emissions behavior in its smaller neighboring EUN countries, we employ a panel dataset comprising over 100 countries during the sample period of 2002-2019. To test the relationship between EU environmental policy stringency and CO_2 emissions, we regress country-level CO2 emission per capita on the stringency of EU climate policies while controlling for income, squared income, and regulatory quality as below:

$$\begin{aligned}\text{Log(CO2 per capita)} &= \beta_1 \cdot \text{Log(Real GDP PPP)} + \beta_2 \cdot \text{Eustringency} + \beta_3 \cdot \text{Eustringency} \cdot \text{Dummy\_EUN} + \beta_4 \\ &\cdot \text{Regulatory Quality} + (\text{Lag\_Square Real GDP PPP}) + \alpha_i + \delta_t + \mu\end{aligned}$$

The regression examines the relationship between CO_2 emissions and a set of independent variables, including Log(Real GDP PPP), Eustringency, Eustringency * Dummy_EUN, and Regulatory Quality. The coefficients of these variables, denoted β_1, β_2, β_3, and β_4, respectively, are estimated using a regression model. Here, Dummy_EUN is a binary variable that takes a value of 1 if the country is a member of our sample in the EU neighborhood, and 0 otherwise. The regulatory quality variable in our study is measured using the Worldwide Governance Indicators Index from the World Bank. The inclusion of the variable (Lag_Square Real GDP PPP) allows us to examine the potential effects of economic growth on CO_2 emissions. Fixed effects for each country i, denoted α_i, and each year t, denoted δ□, are employed to control for unobserved heterogeneity and time-specific factors that may affect CO_2 emissions. The error term, denoted μ, captures all other factors that affect CO_2 emissions but are not included in the model.

To ensure the robustness of our findings, we conducted additional analyses using alternative variables and specifications. Specifically, we examined the use of emission intensity as a dependent variable instead of CO_2 emissions per capita, and we used the time lag of GDP growth rate instead of real GDP PPP as an independent variable. Our results showed that the findings were consistent with our baseline scenario, as well as with a time lag of GDP PPP and GDP square. We also investigated the effect of regulatory quality on the relationship between CO_2 emissions and independent variables. Interestingly, we found that regulatory quality significantly affects CO_2 emissions per capita, but not emission intensity. This suggests that the impact of regulatory quality on CO_2 emissions may vary depending on the measure of emissions used. Our robustness checks provide further support for the main findings of our study and contribute to a comprehensive understanding of the factors influencing CO_2 emissions in the studied countries.

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