Analysis of the Impact of Environmental Taxes on CO2 Emissions from the Energy Sector

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Abstract:

This article analyzes the impact of a carbon tax in a hypothetical high-growth and low-growth economy. Carbon taxes are found to increase the cost of CO2 emissions, which provides an incentive for CO2 emitters to use low-carbon fuels or take other measures to reduce CO2 emissions.
Carbon capture, use and storage technologies offer fuel producers another option for reducing CO2 emissions, leading to lower costs associated with carbon taxes. We assume that CO2 can be captured from some industrial processes and electricity generation and then sold to enhanced oil recovery operations.
Given the concerns about carbon pricing, it is important to know that more than 70% of greenhouse gas emissions are domestic, and trade and competitiveness issues are much less important in addressing these emissions sources.

Keywords : taxes, carbon, climate change, high-growth, low-growth

JEL classification **:** H23, Q53, Q57

Introduction

Carbon taxes are considered "the most powerful and effective of the various mitigation strategies to reduce CO2 emissions from burning fossil fuels" (IMF, 2019). They are taxes on the carbon content of fossil fuels and lead to higher prices coal and other fossil fuels There are some countries where these instruments are not cost-effective, for example fuel and electricity prices are set below cost recovery.

The most recent IMF estimates of the combined value of after-tax energy subsidies (for coal, oil, electricity, natural gas), also reflecting the environmental damage associated with global warming, pollution, traffic congestion, is 5.2 trillion of US dollars (over 6% of world GDP), of which 85% are represented by coal and oil.

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Methodology and Data

Carbon taxes are a policy mechanism designed to reduce the energy sector's contribution to anthropogenic climate change. In this analysis, we apply three levels of carbon taxes, which gradually increase over the projection period, with the values recorded in 2022 as the reference.

The analysis focuses on the impact of the three carbon taxes (at the level of a country's economy) on energy-related CO2 emissions, without quantifying the economic/social costs associated with a carbon tax policy and without assessing the social benefits of the reduction these emissions.

Choice of data

As of 2022, the World Bank Report indicates that 70 jurisdictions, including 47 national jurisdictions as well as subnational jurisdictions, were subject to some form of explicit carbon pricing, covering 23% of all global greenhouse gas emissions. greenhouse.

There is substantial variation in the implicit price of emissions, with many sub-national jurisdictions having values of $15/tonne in China, $25/tonne in most US states and Canada over $35/tonne. In contrast, Japan's tax is set at around $3/tonne and Mexico's at $1.5/tonne.

Also, in the European Union prices vary greatly and are considered among the highest in the world (Table 1). For this reason, we considered representative for the analysis the values of €16 (the value of the existing carbon tax in the countries of Latvia, Poland and Spain), €27 (Denmark, Portugal) and €38 (Austria, Germany implemented in 2021).

Given the large variations in carbon taxes across national jurisdictions, we proposed an analysis of how they, at the level of an economy, influence total, sectoral and fuel-specific CO2 emissions, as well as fuel prices.

Table 1

Carbon taxes, share of greenhouse gas emissions covered and year of implementation in EU countries (as of March 31, 2023)

	Carbon taxes (per ton of CO2)		Share of greenhouse gas emissions covered in jurisdictions	Year of implementation
	Euro	Dolars		
Austria (AT)	€32.50	$35.38	40%	2022
Denmark (DK)	€24.37	$25.43	35%	1992
Estonia (EE)	€2.00	$2.18	6%	2000
Finland (FI)	€76.92	$83.74	36%	1990

France (FR)	€44.55	$48.50	35%	2014
Germany (DE)	€30.00	$35.38	40%	2021
Iceland (IS)	€35.40	$36.33	55%	2010
Ireland (IE)	€48.45	$52.74	40%	2010
Latvia (LV)	€15.98	$17.25	3%	2004
Liechtenstein (LI)	€ 120.16	$ 130.81	81%	2008
Luxembourg (LU)	€44.19	$48.11	65%	2021
Netherlands (NL)	€51.07	$55.59	12%	2021
Norway (NO)	€83.47	$90.86	63%	1991
Poland (PL)	€16.27	$17.57	4%	1990
Portugal (PT)	€23.90	$26.01	36%	2015
Slovenia (SI)	€17.30	$18.83	52%	1996
Spain (ES)	€15.98	$17.25	2%	2014
Sweden (SE)	€ 115.34	$ 125.56	40%	1991
Switzerland (CH)	€ 120.16	$ 130.81	33%	2008
Ukraine (UA)	€0.75	$0.82	71%	2011
United Kingdom (GB)	€20.46	$22.28	21%	2013
	€44.49	**$48.56**	**37%**	
EU ETS (For Reference)	€88.46	$96.30	38%	2005

Source: World Bank, "Carbon Pricing Dashboard", last updated 31 March 2023, https://carbonpricingdashboard.worldbank.org/map_data

Because the majority of emissions reductions from carbon taxes come from the electricity sector, we will analyze the impact of carbon taxes using the model. In this analysis we do not quantify the economic or social costs associated with a carbon tax policy, nor do we assess the climate benefits, but instead focus on national CO2 emissions in three carbon tax cases.

Methodology

We will consider three carbon taxes with values of €16, €27 and €38, which we propose to introduce at the level of the entire economy of a country starting in 2023. We consider these taxes to grow by 5% per year, thus reaching in 2050 at values of €60.84, €100.80, €141.12 per ton of CO2.

Table 2, Table 3, Table 4, shows the three selections of taxes proposed to be implemented in the national energy system and how they evolve until 2050.

Fuel costs rise with the inclusion of carbon dioxide taxes, and these are reflected in the prices of petrol, diesel, natural gas and coal. These taxes also reduce consumers' disposable income for non-energy purchases.

Table 2

€16 tax on economy-wide CO2 emissions and their effects on energy product prices

Carbon tax €16 fee	Carbon tax in 2023 (€/physical unit of fuel)	Carbon tax in 2050 (€/physical unit of fuel)
benzine	+0,1404€	0,518€
DIESEL	+0,162€	+0,605€
natural gases	+0,896€	+3,337€
coal	+29,527€	+111,272

Source: data processed by the authors based on the Carbon Pricing Dashboard

Table 3

€27 tax on economy-wide CO2 emissions and their effects on energy product prices

Carbon tax €27 fee	Carbon tax in 2023 (€/physical unit of fuel)	Carbon tax in 2050 (€/physical unit of fuel)
benzine	+0.227€	0.864€
DIESEL	+0.27€	+1.015€
natural gases	+1.490€	+5.562€
coal	+49.216€	+185,436€

Source: data processed by the authors based on the Carbon Pricing Dashboard

Table 4

€38 tax on economy-wide CO2 emissions and their effects on energy product prices

Carbon tax €27 fee	Carbon tax in 2023 (€/physical unit of fuel)	Carbon tax in 2050 (€/physical unit of fuel)
benzine	+0.324€	1.210€
DIESEL	+0.378€	+1.415€
natural gases	+2.084€	+7.787€
coal	+68.904€	+259.2€

Source: data processed by the authors based on the Carbon Pricing Dashboard

Referențialul din 2022 arată o scădere , dar și o revenire a cererii de energie legate de COVID-19 în 2020 și a emisiilor de CO2 aferente în 2021.

Results

In the three cases where we add carbon taxes to the 2022 (Table 5) baseline case, energy-related CO2 emissions decline before leveling off in the last 10 to 15 years of the projection period, despite tax increases. This phenomenon occurs because many CO2-reducing actions, such as replacing coal-fired electricity generation with lower-CO2 natural gas or emission-free renewables, occur early in the projection period.

	2020	2025	2030	2035	2040	2045	2050
Tax in 2022 per metric ton of CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Annual CO2 emissions	4.941	5.085	4.991	4.908	4.925	5.001	5.117
(million metric tons)		144.72	-93.96	-82,08	16.2	76.68	114.48
Five-year change in CO2 emissions (million metric tons)							
$16 fee	0.00	17.863€	22.798€	29.095€	37.130€	47.390€	60.48€
Tax in 2022 per metric ton of CO2	4.941	4.716	4.389	4.199	4.180	4.239	4.262
Annual CO2 emissions (million metric tons)		-225.72	-327.24	-189	-18.36	58.32	23.76

Five-year change in CO2 emissions (million metric tons)							
$27 fee	0.00	29.764€	37.99€	48.492€	61.884€	78.980€	100.807€
Annual CO2 emissions (million metric tons)	4.941	4.575	4.231	4.064	4.061	4.087	4.093
Five-year change in CO2 emissions (million metric tons)		-365,04	-345,6	-166,32	-3,24	25,92	14,04
$38 fee							
Tax in 2022 per metric ton of CO2	0.00	41.67€	53.19€	67.88€	86.63€	110.57€	141.12€
Annual CO2 emissions (million metric tons)	4.942	4.501	4.155	4.006	3.973	3.991	4.013
Five-year change in CO2 emissions (million metric tons)		-439.56	-345.6	-149.04	-33.48	18.36	21.6

Source: data processed by the authors based on the Carbon Pricing Dashboard

The decrease in CO2 emissions also occurs due to the increase in actions taking place at the beginning of the projection period to reduce CO2 emissions, such as replacing coal-fired electricity generation with lower CO2-emitting natural gas or renewable sources without CO2 emissions.

Other mitigation strategies that may be more expensive, such as reducing CO2 from chemical production or increasing the number of alternative fuel vehicles, because they require taxes that are generally higher than those obtained in this analysis.

Conclusions

Applying the three cases of hypothetical carbon taxes of €16, €27, or €38 on fossil fuels in a country's economy starting in 2023, and increasing these taxes by 5% each year until 2050, we obtained estimated energy prices, fuel consumption, carbon capture and sequestration, carbon intensity and overall energy-related CO2 emissions relative to the 2022 reference case.

Assuming that a tax on fossil fuels is proportional to their carbon content, we observed significant differences in estimated energy prices, fuel consumption, carbon capture and reduction, carbon intensity and overall energy-related CO2 emissions.

Analyzing energy-related CO2 emissions projections, we find that they are lower when a carbon tax is applied to fossil fuels, and higher taxes result in larger CO2 emissions

reductions compared to the baseline case. Total energy-related CO2 emissions in 2050 are progressively lower for the €16 tax (17%), €27 tax (20%) and €38 tax (22%) than the 2022 baseline.

In each of the carbon tax cases based on the 2022 baseline, CO2 emissions decline at the beginning of the projection period before leveling off in the late 2030s. The electricity sector is the most responsive to carbon taxes. In this sector, coal is losing market share to natural gas and zero-carbon generation sources faster than in the 2022 baseline.

Future Directions

The presented case study can be a guide for the introduction of a carbon tax in Romania, where the energy mix is still largely based on fossil fuels, mainly oil and gas. A coal phase-out target has been set for the year 2032, but no phase-out dates have been set for gas and oil.

Gas is used as a transition fuel, therefore many fossil gas investments are still planned in various strategic or programmatic documents. These investments consist in the expansion of the gas distribution system and the new fossil gas-based units included in the decarbonization plan of the largest coal producer Complexul Energetic Oltenia (OEC). Specifically, two new gas-fired power plants are planned to come online in 2026, and an offshore gas project began production in 2022.

The decarbonisation process of the nue OEC is very transparent and also all relevant mine closures and rehabilitation timelines are not made public.

Regarding renewable sources, although the green certificate support scheme ended in 2016, no similar mechanism has been implemented to stimulate investments in renewable energy, despite Romania's considerable potential. Progress has been made on a state aid scheme for investments in wind and solar capacity. Under the Recovery and Resilience Plan, approved by the European Commission in March 2023, direct subsidies will be awarded to wind and solar projects selected through a tender process.

In the National Energy and Climate Plan (PNEC), Romania does not specify an objective to reduce greenhouse gas (GHG) emissions for the transport sector. The Environmental Fund Administration has several programs to support the replacement of old vehicles with electric and low-emission vehicles and a program to increase the number of charging points for electric and plug-in hybrid vehicles.

There is much controversy surrounding one of these existing national support schemes that allows funds to be allocated to internal combustion engine vehicles, which does not help reduce GHG emissions.

The energy efficiency of buildings in Romania still needs to be improved. While the Environmental Fund Administration has implemented several programs to increase efficiency, methodological standards are still needed for proper enforcement of the Energy Performance/Emissions Standards Act.

Romania's performance is mixed, with low ratings in the Climate Policy and Renewable Energy categories, average in energy use and high in GHG emissions.

To improve Romania's climate policy, more ambitious climate and energy targets for 2030 and 2050 and more development of the offshore wind sector are needed. It is scheduled to use gas as a transition fuel; therefore, many fossil gas investments are still planned through various strategic or programmatic documents. Also, energy efficiency in all energy-consuming sectors should be improved and a concrete plan to alleviate energy poverty should be implemented.

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