

The Fiscal Implications of Carbon Taxation: Empirical Evidence from Selected Mediterranean Economies

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Abstract: This study examines the impact of carbon taxation on fiscal sustainability in selected Mediterranean countries—France, Slovenia, and Spain—over the period 2008–2023. Mediterranean countries are undergoing a structural transition toward economic systems that rely more on clean energy and place environmental sustainability at the center of development strategies. In this context, taxation plays a central role in shaping incentives and generating public revenues needed to finance the transition, while fiscal sustainability has become increasingly important due to rising public expenditures and potential revenue instability associated with climate change.

The analysis employs a panel data framework in which fiscal sustainability is measured using the public debt-to-GDP ratio. Carbon taxation represents the main explanatory variable, alongside employment, inflation, and CO₂ emissions as control variables, with country and year effects explicitly modeled. The study evaluates whether carbon taxation can contribute to both environmental objectives and long-term fiscal capacity.

The empirical results indicate a positive and statistically significant association between carbon taxation and the debt-to-GDP ratio across model specifications. This relationship reflects the broader macro-fiscal context in which carbon pricing policies are implemented, particularly during periods of economic stress, rising expenditures, and policy interventions such as energy subsidies and compensation measures. Carbon taxation contributes to revenue generation and supports fiscal balances, although overall debt dynamics remain influenced by structural pressures and external shocks.

The findings also highlight that the fiscal role of carbon taxation is transitional. While it generates meaningful revenues in the short to medium term, its tax base may decline as emissions are reduced. Overall, carbon taxation can support fiscal sustainability when integrated into policy frameworks that balance environmental effectiveness, revenue generation, and social considerations.

Keywords: Carbon Tax, Fiscal Sustainability, Public Debt-to-GDP Ratio, Mediterranean Countries, Environmental Taxa.

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1 Introduction

Mediterranean countries are moving—at different speeds—toward economic systems that rely more on clean energy and place environmental sustainability at the center of development strategies. This

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transition is not simply a technological shift from fossil fuels to renewables; it is a structural transformation that affects production patterns, investment priorities, labor markets, and the composition of public revenues and expenditures. In this context, the fiscal system, particularly taxation, plays a central role in shaping incentives and generating the public revenues needed to support this transition.

At the same time, climate change is expected to increasingly affect fiscal sustainability. It can raise public expenditures through higher spending on disaster response, infrastructure repair, health costs, and long-term adaptation investments. It can also weaken public revenues if climate impacts reduce economic activity in vulnerable sectors. As a result, governments face a fiscal “double pressure,” where spending needs rise while revenues may become more volatile or decline (Rose, 2010).

This highlights the growing interdependence between environmental policy and fiscal policy, and the need for policy instruments that can generate co-benefits across both domains.

Carbon taxation has received increasing policy attention as a key instrument for addressing this challenge. It is commonly defined as a fee imposed on the carbon content of fuels or directly on emissions, with the objective of internalizing the negative externalities associated with greenhouse gas emissions (Gimenez, 2012; Kuo, 2016; Nyahuna & Doorasamy, 2022). By attaching a monetary cost to carbon-intensive activities, carbon taxes influence behavior, encourage the adoption of cleaner technologies, and generate public revenues. However, their effectiveness depends on policy design, country-specific conditions, and their interaction with broader fiscal frameworks.

Against this background, the present study examines the impact of carbon taxation on fiscal sustainability in selected Mediterranean countries—France, Slovenia, and Spain—during the period 2008–2023 using a quantitative panel data approach. Fiscal sustainability is measured using the public debt-to-GDP ratio, while carbon taxation represents the main explanatory variable, alongside employment, inflation, and CO₂ emissions as control variables, with country and year effects explicitly modeled.

The study is motivated by a central research question: What is the effect of a carbon tax on fiscal sustainability? In addition, it addresses several related questions concerning the distributional effects of carbon taxation on households, particularly low-income groups, the role of tax design features in shaping effectiveness and revenue outcomes, the implementation experiences of the selected countries, and the sectoral impacts of carbon taxation across energy, transport, and industry. Through this framework, the study aims to provide empirical evidence on whether carbon taxation can serve as a transitional instrument that supports both environmental objectives and fiscal sustainability.

2 Research Questio

The main question this study seeks to answer is: What is the effect of a carbon tax on fiscal sustainability?

Sub-Question of the study:

1. What challenges could prevent the introduction and application of a carbon tax effectively?
2. How would a carbon tax affect key sectors (energy, transport, and industry) and overall economic

activity?

3. Can a carbon tax generate stable and sufficient revenues for governments over time?
4. How would a carbon tax affect households (especially low-income groups), and what measures can reduce negative social impacts?
5. How would a carbon tax fit with the current tax system, energy prices, and subsidy reforms?
6. Would a carbon tax improve fiscal sustainability (budget deficit and public debt), and through which channels?

3 Methodology

This study sets out the methodological framework used to examine whether carbon taxation and macroeconomic conditions are associated with the public debt burden of selected European economies. The dependent variable is the public debt to GDP ratio (hereafter, debt/GDP). The focal independent variable is carbon tax; employment, inflation, and CO₂ emissions enter as conditioning (control) variables. Country and year effects are modelled explicitly. The analysis spans France, Spain, and Slovenia over 2008–2023. The study details the research design, data sources and preparation, variable operationalization, statistical techniques, model specification and estimation, diagnostic checks, and ethical and validity considerations.

4 Thesis Structure

To answer the main research question and the subsidiary questions, the study is divided into three sections as follows:

1. **Section One:** Green Fiscal Reform between Theoretical Foundations, Policy Instruments, and Implementation Challenges.
 2. **Section Two:** Carbon Tax Policies: Concept, Rationale, Impacts, Pricing Structure, and Institutional and Distributional Challenges.
 3. **The Third Section:** The Conceptual Framework of Fiscal Sustainability
- This is in addition to a conclusion summarizing the main findings reached by the study.

Section One: Green Fiscal Reform between Theoretical Foundations, Policy Instruments, and Implementation Challenges.

Green fiscal reform—often termed environmental or ecological fiscal reform—denotes the strategic use of tax and price instruments to mobilize public revenues while advancing environmental objectives (Hewett & Ekins, 2014; OECD). It also includes expenditure-side measures that expand public investment in low-carbon technologies and green assets, aligning fiscal policy with sustainability transitions.

Operationally, green fiscal reform relies on three main instrument families (Metcalf, 2015). First, correcting underpricing of publicly provided goods with environmental externalities such as energy, water, and waste services, where tariffs below marginal social cost lead to overconsumption, resource depletion, pollution, and fiscal strain. Second, environmental subsidies that support the adoption of cleaner technologies, such as replacing inefficient appliances, which shift behavior and investment but require fiscal spending (Elshamy & Ahmed, 2017). Third, Pigouvian taxation of pollutants, including carbon and energy taxes, which internalize environmental damages by incorporating social costs into market prices (Heindl & Löschel, 2015).

These reforms improve environmental quality and economic efficiency by reducing emissions, pollution, and resource waste while promoting renewable energy (Elshamy & Ahmed, 2017). They are grounded in the need to internalize environmental externalities in fiscal systems (OECD, 2011; Pigou, 1920; Stern, 2007).

Traditional fiscal systems often exacerbate environmental harm, particularly through fossil fuel subsidies that distort prices and increase emissions (Coady et al., 2019). Green fiscal reforms address this by restructuring taxes and subsidies in line with the “polluter pays” principle (Baumol & Oates, 1988), while recycling revenues into green investment or social compensation (OECD, 2017).

Key objectives include correcting market failures and mobilizing resources for green investment through carbon pricing, subsidy reform, and public spending on renewable energy and ecosystem restoration (Stiglitz & Stern, 2017; Whitley & van der Burg, 2015; World Bank, 2021).

A major benefit is the “double dividend,” combining environmental improvement with economic efficiency through revenue recycling (Goulder, 1995), although equity concerns remain, especially for low-income households affected by higher energy prices (Parry et al., 2014).

GFRs support climate and sustainability goals, including the Paris Agreement and SDGs (UNEP, 2019), but face political resistance and distributional challenges requiring gradual implementation, transparency, and compensation mechanisms (Lockwood, 2015; IMF, 2013; OECD, 2019). Globally, adoption of carbon pricing is expanding (World Bank, 2022), alongside efforts to reform fossil fuel subsidies and integrate just transition policies (ILO, 2015). Ultimately, green fiscal reform represents a structural shift toward embedding environmental sustainability within fiscal policy and economic governance.

Section Two: Carbon Tax Policies: Concept, Rationale, Impacts, Pricing Structure, and Institutional and Distributional Challenges.

Carbon Tax definition

A carbon tax is a government-imposed price on greenhouse-gas (GHG) emissions, typically levied per ton of carbon-dioxide equivalent (tCO_{2e}) released from burning fossil fuels (oil, gas, coal). Assessed upstream on fuel producers or distributors, the charge is passed through to consumers via fuel prices, utility bills, and—indirectly—goods and services. Effective designs set a predictable, rising price path—often argued to reach roughly US\$100–200/tCO_{2e} over coming decades—to drive sustained decarbonization and clean-technology scale-up (Omolere, 2024).

Carbon Tax Impacts

When set at meaningful levels and phased predictably, a carbon tax delivers economy-wide emissions reductions by raising the relative cost of carbon-intensive activities and rewarding lower-carbon choices across electricity, transport, buildings, and industry. Power systems progressively shift away from coal toward renewables and other low-carbon sources; manufacturers adopt efficiency and process innovations; households electrify end uses and retrofit buildings (Omolere, 2024). The persistent price signal increases expected returns to clean technologies, accelerating learning-by-doing and diffusion, while revenue recycling cushions distributional impacts so that many lower-income households can be held harmless—or even come out ahead—after dividends or targeted transfers.

Macroeconomically, near-term inflation effects are typically modest when increases are phased, and medium-term outcomes can be growth-neutral or positive if revenues fund productivity-enhancing investments or reduce distortionary taxes. Local co-benefits arrive quickly: lower fossil combustion cuts particulate matter and other pollutants, improving health outcomes and reducing healthcare costs, especially in urban and industrial corridors (Zhao, 2024). For trade-exposed sectors, well-designed competitiveness provisions limit relocation pressures without undermining incentives to reduce emissions at the margin. Perhaps most importantly, the tax clarifies marginal abatement costs across the economy, guiding regulators and investors toward the highest-impact complementary actions and enabling periodic recalibration of the rate as technologies, costs, and climate objectives evolve—thereby embedding an adaptive, evidence-based logic into the climate policy mix (IMF, 2013).

Carbon Tax Design & Rates

A well-designed carbon tax begins with a clear, comprehensive tax base and a strategic point of imposition. Levying the charge upstream—on fuel producers and importers—reduces compliance points, aligns liabilities with carbon content, and transmits a uniform signal through fuel prices to downstream users across power, transport, buildings, and industry (Metcalf & Weisbach, 2009). Coverage should be as economy-wide as administratively feasible, with explicit rules for sectors that are hard to measure directly (e.g., process emissions) and for non-CO₂ greenhouse gases expressed in CO₂-equivalent terms. Limiting exemptions avoids distortions and leakage of emissions to untaxed activities; where carve-outs are unavoidable, they should be temporary, transparent, and paired with a plan to expand coverage over time (OECD, 2017).

Price path and credibility are central to investment decisions. A carbon tax should follow a predictable, rising trajectory that is announced in advance—via annual escalators or multi-year schedules—to steer capital toward low-carbon technologies and prevent lock-in of long-lived, emissions-intensive assets (Stiglitz & Stern, 2017). Because technology costs and macroeconomic conditions evolve, statutes can include periodic reviews and “guardrails” (floors/ceilings or automatic adjustments) that maintain credibility while allowing data-driven recalibration (OECD, 2017). To manage competitiveness and leakage risks in trade-exposed, energy-intensive sectors, policymakers can deploy output-based rebates or border carbon adjustments that preserve marginal incentives to decarbonize while limiting relocation pressures (Metcalf & Weisbach, 2009; OECD, 2017).

Revenue recycling determines distributional outcomes and political durability. Using proceeds for lump-sum dividends can render most low- and middle-income households whole or better off; tax swaps that reduce distortionary levies on labor or capital can enhance efficiency (the “double dividend”); and targeted spending on grids, transit, RD&D, and just-transition support amplifies emissions impacts and social acceptance (IMF, 2013; OECD, 2017). Crucially, equity goals are best met outside the price itself—via transfers and credits—rather than by diluting the uniform carbon signal (Metcalf & Weisbach, 2009).

According to the Europ Tax Foundation (2025), as of April 1, 2025, European carbon tax rates display striking variation, reflecting differing policy priorities, coverage choices, and interactions with emissions trading systems. Sweden currently levies the continent’s highest carbon tax at €134.06 (\$144.62) per ton, closely followed by Switzerland and Liechtenstein at €126.10 (\$136.04). At the other end of the spectrum, Poland’s rate is a token €0.09 (\$0.10) per ton and Ukraine’s is €0.68 (\$0.73), underscoring how political economy, sectoral coverage, and administrative capacity shape pricing outcomes. Across the 23 European countries with a carbon tax, the average rate is €57.10 (\$61.60), a midpoint that masks a dispersion of more than three orders of magnitude (Europe Tax Foundation, 2025). This spread translates

into markedly different abatement incentives at the margin and, by extension, heterogeneous investment signals for fuel switching, process efficiency, and low-carbon technologies across power, transport, buildings, and industry.

The data show wide variation in European carbon tax designs across rates, coverage, and vintages. Among the listed jurisdictions, Liechtenstein levies the highest rate at €126.09 (\$136.03) per ton, while Latvia and Albania sit at the lower end with €15.00 (\$16.18) and €12.69 (\$13.69), respectively. Longstanding adopters include Finland (1990) and Denmark (1992), whereas Germany and Austria introduced taxes only in 2021–2022. Coverage of greenhouse gas emissions also differs markedly: Luxembourg and Liechtenstein tax about 72 percent of national emissions, Albania covers 73 percent, and Spain-like narrow scopes are absent here—yet Latvia (2 percent) and Estonia (9 percent) illustrate minimal reach. Ireland and Finland pair mid-to-high rates (€63.50 and €62.00) with moderate coverage (30–39 percent), while Hungary’s 2023 levy is reported with 0 percent coverage, signaling either early-stage implementation or a narrow base (See table 1.1).

Jurisdiction	Carbon Tax Rate – Euros	Carbon Tax Rate – US Dollars	Share of Jurisdiction’s GHG Emissions Covered (2024)(a)	Year of Implementation
Albania (AL)	€ 12.69	\$ 13.69	73%	2022
Austria (AT)	€ 55.00	\$ 59.33	36%	2022
Denmark (DK)	€ 100.51	\$ 108.43	44%	1992
Estonia (EE)	€ 25.00	\$ 26.97	9%	2000
Finland (FI)	€ 62.00	\$ 66.89	39%	1990
France (FR)	€ 44.60	\$ 48.11	41%	2014
Germany (DE)	€ 55.00	\$ 59.33	39%	2021
Hungary (HU)(b)	€ 36.15	\$ 39.00	0%	2023
Iceland (IS)	€ 55.67	\$ 60.06	36%	2010
Ireland (IE)	€ 63.50	\$ 68.50	30%	2010
Latvia (LV)	€ 15.00	\$ 16.18	2%	2004
Liechtenstein (LI)	€ 126.09	\$ 136.03	72%	2008
Luxembourg (LU)	€ 54.27	\$ 58.55	72%	2021

Table 1.1: Carbon Tax Rates, Share of Covered Greenhouse Gas Emissions, and Year of Implementation in European Countries (source: Europe Tax Foundation, 2025).

Rates alone do not determine effectiveness; the coverage and scope of the underlying tax base are equally decisive. Carbon taxes can apply not only to carbon dioxide but also to methane, nitrous oxide, and fluorinated gases, yet countries vary widely in what they tax and where along the value chain they

impose the charge. Spain, for instance, taxes only fluorinated gases, capturing roughly 2 percent of national greenhouse gas emissions and thus providing a narrow price signal relative to jurisdictions that tax fossil fuels comprehensively (Europe Tax Foundation, 2025). By contrast, Albania, Liechtenstein, and Luxembourg cover more than 72 percent of their emissions, pairing relatively broad tax bases with clearer incentives to decarbonize across sectors. These choices interact with the presence of emissions trading systems: all EU Member States, along with Iceland, Liechtenstein, and Norway, participate in the EU ETS; the United Kingdom operates the UK ETS post-Brexit; and Switzerland runs an ETS linked to the EU ETS since January 2020 (Europe Tax Foundation, 2025). . Most European countries that levy a carbon tax also participate in an ETS, which can enhance overall coverage but complicate rate comparisons and policy impacts (See figure 1).

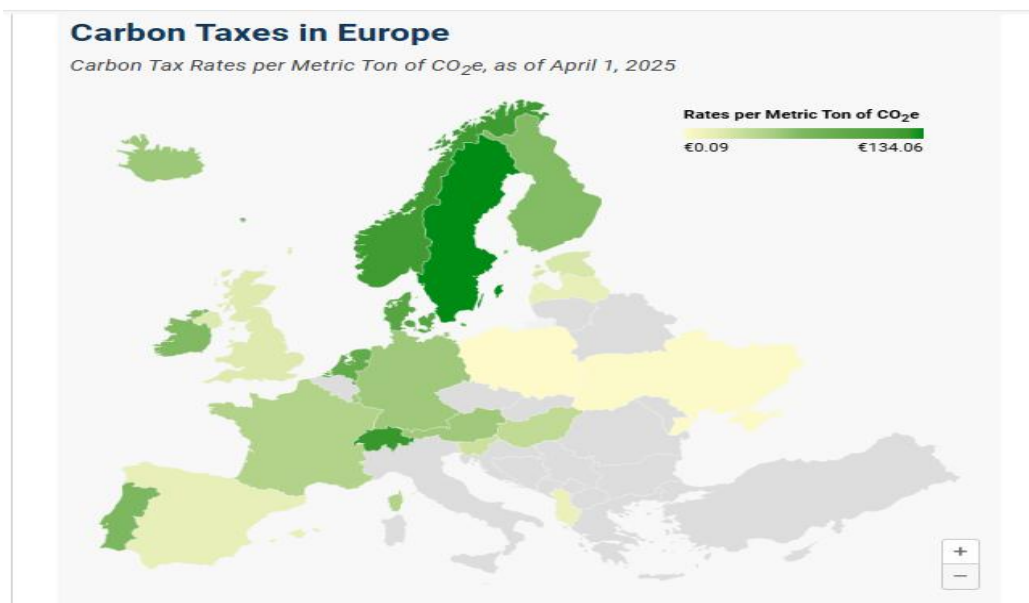


Fig.1: Carbon Tax Rates in Europe in 2025 (Source: Europe Tax Foundation, 2025).

Where national carbon tax bases overlap with ETS-covered emissions—as in Finland, Norway, and Portugal—double taxation concerns emerge for the overlapping tonnage. In such cases, raising a national tax on already capped emissions may simply shift abatement to untaxed sources while leaving total ETS emissions unchanged unless allowances are canceled or the cap is tightened. Several countries also layer multiple instruments—excise duties, surcharges, or parallel ETSs—creating different implicit and explicit prices; for comparability, analyses typically cite the highest applicable rate even though a uniform, economy-wide price would be more efficient. Policy dynamics remain fluid: Germany (2021) and Austria (2022) introduced carbon taxes that are scheduled to transition into ETS frameworks by 2026; Albania (2022) and Hungary (2023) adopted new carbon taxes; Catalonia is considering a subnational tax; and Turkey is weighing a national ETS. Taken together, Europe’s landscape features high leaders like Sweden and Switzerland, ultra-low outliers such as Poland and Ukraine, and a center of gravity around the mid-€50s per ton—yet the real climate leverage depends on how rates, coverage, and ETS interactions are aligned to deliver durable, economy-wide price signals.

The key challenges for the carbon tax

Designing and sustaining an effective carbon tax faces intertwined political-economy, distributional, and technical hurdles.

- a) Public acceptability: visible increases in fuel and electricity prices can trigger resistance if households doubt environmental efficacy or perceive the policy as unfair. Acceptance improves when governments precommit to a clear, rising price path, explain benefits, and make revenue uses salient—such as household dividends, tax reductions, or funding for public goods (OECD, 2019; Stiglitz & Stern, 2017). Absent credible communication and transparent earmarking, reforms are vulnerable to backlash or rollback (OECD, 2019).
- b) Second, distributional impacts can be regressive without compensating measures, because energy and basic goods make up a larger budget share for low-income households. The central design challenge is to recycle revenues in ways that protect vulnerable groups while preserving a uniform carbon price—ideally through lump-sum transfers, targeted credits, or reductions in distortionary taxes like payroll or income taxes (IMF, 2013; OECD, 2019). Experience with energy-price reforms shows that failing to build social protection mechanisms and delivery systems early can erode legitimacy and stall implementation (IMF, 2013).
- c) Third, competitiveness and carbon leakage concerns persist for trade-exposed, energy-intensive industries. Firms facing higher input costs may lose market share to producers in jurisdictions with weaker carbon constraints, potentially shifting rather than reducing global emissions. Policymakers can deploy output-based rebates or border carbon adjustments to mitigate these risks, but both instruments are administratively and diplomatically complex, requiring robust emissions accounting, product-level benchmarks, and consistency with trade rules (OECD, 2019; Stiglitz & Stern, 2017). If safeguards are not credible, domestic coalitions may press for exemptions that undermine the tax's environmental integrity (OECD, 2019).
- d) Fourth, coverage gaps and policy interactions complicate outcomes. Many carbon taxes apply to only a subset of fuels, sectors, or gases, leaving large emission sources unpriced. Where a tax overlaps with an emissions trading system (ETS), the combined effect depends on coordination: without allowance cancellation or a tighter cap, a tax on ETS-covered sources may simply shift abatement within the capped sector without changing total emissions (OECD, 2019; World Bank, 2024). Clear delineation—by sectors or through price floors in ETSs—helps avoid double regulation while maintaining environmental ambition (World Bank, 2024).
- e) Fifth, price levels remain too low and uneven to align with temperature goals. Despite record revenues and expanding coverage, only a small share of global emissions is priced at or above ranges consistent with the Paris Agreement, reflecting political constraints, energy-affordability concerns, and macroeconomic shocks (World Bank, 2024). Expert assessments emphasize the need for meaningful prices now that rise predictably over time, paired with complementary measures to address non-price barriers (Stiglitz & Stern, 2017).
- f) Finally, administrative capacity and data systems are pivotal. Effective carbon taxation relies on accurate measurement of fuel carbon content, efficient collection at a limited number of upstream points, and robust monitoring to deter evasion. Many jurisdictions still lack integrated energy tax bases, social registries for targeted transfers, and real-time analytics to evaluate incidence and adjust design; strengthening these institutions is vital for broad-based, enforceable, and credible policy (IMF, 2013; OECD, 2019).

The Third Section: The Conceptual Framework of Fiscal Sustainability

Fiscal sustainability has become a central concern for local governments across the globe, as they balance day-to-day service delivery with long-term financial health in increasingly volatile economic conditions (GAO Et Al., 2021; López Subires et al., 2019; Rodríguez Bolívar et al., 2016). Broadly conceived, fiscal sustainability refers to a government's ability to maintain its spending and revenue strategies over extended horizons without undermining financial stability, sliding toward insolvency, or jeopardizing its capacity to honor future obligations. A fiscally sustainable government can reliably generate sufficient revenues to meet present and prospective expenditures without leaning unduly on debt accumulation or inflationary finance. Despite its widespread use in policy debates, the phrase "fiscal sustainability" still lacks a single, universally accepted definition; practitioners and scholars often operationalize it through measurable proxies and prudential thresholds that capture solvency and resilience over time.

A widely cited benchmark is the International Monetary Fund's (IMF) practical definition, which centers on stabilizing the public debt-to-GDP ratio at a chosen level or converging toward a specified target range. In this framing, fiscal policy is deemed sustainable when the government can keep the ratio of public debt to national income from trending upward, thereby signaling that, on average, the budgetary stance is compatible with long-run solvency (Akyüz, 2007). The debt-to-GDP ratio thus serves as a summary indicator of a state's ability to manage indebtedness, smooth shocks, and avoid excessive rollover or refinancing risk. Stability in this ratio typically implies that, over the cycle, revenues and primary expenditures are sufficiently aligned to prevent debt dynamics from deteriorating—an interpretation that links macro-fiscal strategy with credible intertemporal budgeting.

To translate this high-level concept into actionable diagnostics, analysts employ a suite of fiscal sustainability indicators. One influential tool is the tax gap indicator, which quantifies how far current tax policy sits from the level needed to stabilize the debt-to-GDP ratio under prevailing and projected spending commitments. By comparing the revenue required for stabilization with the revenue implied by existing tax rates, the tax gap shows the incremental tax effort necessary to close the sustainability shortfall. A negative value indicates that, with current policies, taxes are insufficient to keep debt from rising relative to GDP; conversely, a positive value signals fiscal space under the assumed expenditure path (Chalk & Hemming, 2000). Policymakers value this indicator because it connects forward-looking fiscal arithmetic—growth, interest costs, and primary balances—to an intuitively understood lever: the overall tax burden.

Another cornerstone measure is the public debt-to-GDP ratio, which conveys the relative scale of indebtedness and its potential strain on the budget. As the ratio climbs, the burden of servicing and repaying debt typically intensifies, eroding flexibility to fund services and invest in infrastructure. The International City/County Management Association and other municipal governance bodies treat this ratio as a key gauge of a local government's capacity to meet obligations without shifting disproportionate costs onto future taxpayers. Elevated debt levels can narrow fiscal options, heighten vulnerability to interest-rate or revenue shocks, and raise the specter of distress or default, especially for subnational entities with limited revenue autonomy (Kluza, 2016). Consequently, vigilant monitoring and active debt management—refinancing, maturity smoothing, and prudent new issuance—are critical to preserving sustainability.

Because debt composition shapes risks and policy levers, analysts often distinguish internal (domestic) public debt from external public debt. Internal debt is held by residents or domestic institutions and commonly finances budget shortfalls in many countries. Effective management of domestic

liabilities—through predictable issuance calendars, transparent auctions, and the development of local currency bond markets—can reduce rollover risk and currency mismatches. External public debt, by contrast, is owed to non-resident creditors. While external borrowing can support growth by channeling additional resources into productive investment, its benefits depend on the quality of project selection and implementation. If borrowed funds do not translate into returns that exceed financing costs, external debt can become a drag on growth and heighten exposure to exchange-rate, refinancing, and sudden-stop risks. A significant literature documents that high external debt burdens are associated with weaker growth outcomes, particularly when compounded by short maturities or variable rates.

A third, closely watched metric is the primary balance—the difference between non-interest revenues and non-interest expenditures. The primary deficit indicator isolates the fiscal stance net of interest payments, clarifying whether current policy choices (spending and taxation) are adding to or subtracting from the debt stock before financing costs are considered. A positive primary deficit indicates that the government is spending more than it collects (excluding interest), which mechanically increases debt. Persistent primary deficits, especially when growth is sluggish or interest rates exceed growth rates, can place debt on an unsustainable trajectory, prompting the need for consolidation or revenue measures to restore balance.

Beyond indicators, understanding drivers of fiscal sustainability is essential for policy design. Two fundamental variables are revenue performance and public expenditure dynamics. Generally, stronger and more reliable revenue growth improves sustainability by supporting stable primary balances and accommodating investment needs. Conversely, if expenditures expand faster than revenues over prolonged periods, deficits widen, debt accumulates, and solvency risks escalate. Achieving sustainability, therefore, requires aligning the growth of spending with the growth of revenues—either by strengthening tax capacity and compliance, diversifying revenue bases, or calibrating expenditure commitments to realistic medium-term revenue paths. When spending outpaces revenues persistently, governments often resort to increased borrowing to finance gaps, which, in turn, raises debt service costs and can create a self-reinforcing cycle of fiscal pressure.

For local governments, these challenges are magnified by institutional features: limited tax autonomy, heavy reliance on intergovernmental transfers, and exposure to cyclical revenues such as property transactions or tourism. Localities frequently face “unfunded mandates,” whereby responsibilities expand faster than assigned revenue instruments. In such contexts, fiscal rules (e.g., balanced-budget requirements, debt brakes), medium-term fiscal frameworks, and multi-year capital planning can help ensure that recurrent commitments remain affordable and that investment programs are paced in line with projected revenues and prudent borrowing. Building buffers—rainy-day funds and liquidity reserves—also enhances resilience to shocks.

Operationally, improving administrative capacity is pivotal. Revenue sustainability depends not only on statutory rates but also on the breadth of the tax base, compliance, and enforcement. Modernizing cadaster systems, integrating taxpayer registries, enhancing analytics to detect non-compliance, and simplifying procedures can raise collections without sharp rate hikes. On the expenditure side, public financial management reforms—credible budgets, commitment controls, procurement transparency, and performance-informed allocations—contain arrears, curb waste, and align spending with strategic priorities. Debt management offices that monitor risk indicators (average time to maturity, interest rate refixing, currency composition) and maintain investor communication can lower borrowing costs and stabilize refinancing needs.

Finally, sustainability is not purely a technical exercise; it is also political-economic. Reforms that close tax gaps or rationalize spending often confront distributional trade-offs and stakeholder resistance. Transparent communication, stakeholder engagement, and measures that shield vulnerable groups—such as targeted transfers or phased adjustments—can strengthen the social contract underpinning consolidation efforts. Importantly, sustainability should be framed not as austerity for its own sake but as a pathway to protect service delivery, safeguard intergenerational equity, and expand room for productive public investment. When governments anchor policy in clear objectives—debt stabilization, credible primary balance targets, and realistic growth assumptions—supported by robust institutions and data, they increase the odds of maintaining solvency through shocks and cycles (Gao et al., 2021; López Subires et al., 2019; Rodríguez Bolívar et al., 2016). In sum, while no single metric captures fiscal sustainability in its entirety, a coherent toolkit—debt ratios, tax gaps, primary balances, and composition analyses—combined with disciplined revenue and expenditure management provides a practical framework for local governments to sustain their finances over the long run (IMF; Akyüz, 2007; Chalk & Hemming, 2000; Kluza, 2016).

Interpretation of Findings

At the descriptive level, the mean value of the carbon-tax variable is substantially larger for France than for either Slovenia or Spain in the sample—consistent with widely documented differences in explicit carbon-tax design and the weight of carbon components embedded in energy excises. These econometric patterns, together with institutional histories summarized in the cases, provide a coherent narrative: carbon pricing can supply meaningful near-term revenues and—depending on policy architecture—avoid measurable macroeconomic drag, but its long-run fiscal role is transitional because effective prices erode the taxable emissions base while political economy shapes durability.

Across specifications, the carbon-tax regressor is positive and highly significant. In the employment-controlled model, the estimated coefficient on the carbon-tax variable is $\approx 10,036$ ($SE \approx 728$; $Wald \approx 190$), while employment also enters positively (≈ 2.417 ; $SE \approx 0.223$; $Wald \approx 118$), and the model fit is high ($R^2 \approx 0.962$). In the inflation-augmented model, the carbon-tax coefficient remains positive and significant ($\approx 7,405$; $SE \approx 1,275$; $Wald \approx 33.7$), with overall $R^2 \approx 0.860$. When CO₂ emissions are included, both carbon tax and CO₂ enter positively and significantly (carbon tax $\approx 3,391$; CO₂ ≈ 1.496), with $R^2 \approx 0.977$.

Two points of interpretation follow.

- a) First, **sign and magnitude**. The positive association between the carbon-tax measure and debt-to-GDP should *not* be read as a causal claim that “carbon taxes raise debt.” Rather, the sign is consistent with years in which carbon-price instruments were adjusted amid broader macro-fiscal stresses (e.g., energy-price shocks, post-pandemic consolidations) that simultaneously raised expenditure needs or compressed growth. In France and Spain, for instance, fuel-price volatility prompted policy adjustments (freezes, rebates), while in Slovenia the 2023 floods imposed large reconstruction costs. Case-study chronologies therefore rationalize why debt could rise even as carbon-related receipts strengthened primary balances locally.
- b) Second, **model scope and identification**. The panel covers three countries over ~ 16 years; year effects are included (e.g., the employment model reports a joint Wald test for year dummies of

≈ 381 , $p < 0.001$), which soaks up common shocks but leaves limited degrees of freedom for country-specific dynamics. Data checks (distributional tests) support the chosen GLM family/link, but the small-N, small-T setting, potential simultaneity (e.g., tax policy responding to fiscal stress), and measurement differences in “carbon tax” across countries counsel caution in causal interpretation.

Against that backdrop, the relevant question for fiscal sustainability is not the *reduced-form sign* in isolation, but whether the portfolio of carbon-pricing instruments (explicit CO₂ taxes, energy excises with carbon components, ETS receipts) can (i) mobilize non-distortionary revenue in the near term, (ii) remain politically durable, and (iii) be integrated into credible medium-term frameworks recognizing their “vanishing base.”

France: a large, revenue-oriented energy-tax base with frozen CCE

France’s power sector is largely decarbonised due to extensive nuclear generation, so abatement pressure falls on transport and buildings—the very domains subject to the *contribution climat-énergie* (CCE), the carbon component embedded in TICPE/TICGN/TICC since 2014 (Schubert, 2019). The CCE rose from €7/tCO₂ (2014) to €44.6/t (2018), but a planned path toward €86.2/t (2022) was frozen after the *Gilets Jaunes* protests (European Court of Auditors [ECA], 2022; Schubert, 2019). The Cour des comptes emphasizes that energy taxes historically serve general-budget financing, with the carbon component layering an environmental signal over revenue instruments (Cour des comptes, 2019). This architecture explains why the econometric models—estimated on debt ratios—can show a positive association with the carbon-tax variable even as the primary balance benefits mechanically from CCE-related receipts: in stress years, other fiscal outlays dominate debt dynamics.

Revenue magnitudes are non-trivial: carbon-pricing receipts around €5.9 bn in 2017 and roughly US\$9 bn in 2021 occurred within environmental-tax totals exceeding €40–50 bn (Climate Transparency, 2022; OECD/SDES, 2021). Coverage remains partial (≈ 35 –40% of non-ETS emissions), with exemptions for sensitive sectors (agriculture, taxis, freight), implying room to broaden the base if distributional design is tightened (Climate Transparency, 2022; OECD, 2024). Acceptability research (Douenne & Fabre, 2022) shows support rises with salient, labeled recycling (e.g., dividends). These features—revenue significance, broad but incomplete coverage, and political fragility—map directly to the GLM results: France’s higher average carbon-tax variable (relative to Spain/Slovenia) in the sample coexists with years in which the announced price path stalled, and macro-fiscal pressures persisted (deficit $\approx 5.5\%$ of GDP in 2023).

Analysis

Looking forward, the arrival of ETS2 for road transport and buildings (target start 2027, with a one-year delay clause) will shift pricing upstream to fuel suppliers and introduce EU-level Social Climate Fund resources (European Commission, 2024; European Parliament, 2025; ICAP, 2025). For France, this implies (i) a composition shift from national carbon-tax proceeds toward EU-linked auction flows, (ii) the need to coordinate CCE (frozen) with allowance-price bands to avoid over- or under-shooting effective prices, and (iii) an opportunity to de-risk acceptability via EU-cofinanced compensation—precisely the political constraint revealed in 2018.

Slovenia: early CO₂ tax, high net effective carbon rates, and climate shocks

Slovenia introduced an explicit CO₂ tax in 1996 and today operates a mixed system: explicit CO₂ taxation

on off-ETS fuels, the EU ETS for large sources, and substantial energy excises that implicitly price carbon (ECA, 2022; OECD, 2023). The statutory CO₂ rate was ≈€17.30/t in 2024/25; the obligation to pay was suspended in August 2022 amid the energy crisis and reintroduced in May 2023 (Government of Slovenia, 2023). When excises and ETS are included, *effective* carbon prices are high by OECD standards: the OECD estimates a 2023 net effective carbon rate ≈€82/tCO₂e on average with >80% coverage (OECD, 2023, 2025). Environmental-tax receipts are material for a small economy (≈€1.45 bn in 2021 → €1.91 bn in 2024), with households bearing ~55% of the burden (SORS, 2022–2025).

These facts align closely with the econometrics. First, the positive and significant carbon-tax coefficient is consistent with an instrument that mobilizes revenue in years of fiscal need (e.g., during and after the 2023 floods) while debt ratios are driven by large exogenous shocks and reconstruction spending (IMF, 2024; wiiw, 2023; VoxEU, 2025). Second, the vanishing-base logic is already visible: with high net effective rates and broad coverage, additional revenue buoyancy from higher explicit rates alone is limited unless coverage broadens and exemptions narrow. Third, the political economy—as indicated by the 2022 suspension—recommends rule-based *automatic stabilizers* (e.g., indexation to ETS/ETS2 bands) and salient recycling to households and transport-exposed SMEs to avoid ad-hoc pauses that would compromise credibility.

The macro context is stabilizing (deficit ≈0.9% of GDP in 2024; debt ≈€44.9 bn), and electricity is already relatively low-carbon (nuclear + hydro) (SORS, 2025; World Nuclear Association, 2025). As ETS2 arrives, Slovenia can co-ordinate national excises with allowance prices and leverage the Social Climate Fund to maintain durability—key to ensuring that carbon-related revenues remain a reliable (if transitional) component of the medium-term fiscal framework.

Spain: ETS + energy excises + narrow F-gas tax, with rapid power decarbonisation

Spain does not levy a broad CO₂ tax on transport/heating fuels; instead, its carbon-pricing ensemble comprises EU ETS receipts, energy excises (notably the Hydrocarbons Excise), and a narrow F-gas tax (Tax Foundation, 2024; OECD, 2024). The OECD estimates that ~69% of emissions faced a positive net effective carbon rate in 2023, with explicit prices (ETS + carbon taxes) covering ~34% and the rest via excises (OECD, 2024). Environmental-tax revenues reached ≈€22.9 bn in 2023 (~6.5% of total tax take), and the debt ratio has been on a declining path (~101.8% of GDP by Q4-2024) (INE, 2024; Banco de España, 2025). Power-sector emissions fell sharply as renewables reached record shares (~56% in 2024), improving the efficiency of downstream price signals by making electrification a cleaner substitute (Red Eléctrica, 2024; Reuters, 2024; REE, 2025).

In the econometric sample, Spain's explicit national carbon-tax variable is necessarily small relative to France, and yet the models still register a positive association between the composite carbon-tax measure and debt—again consistent with the fact that 2022–2023 saw sizeable fuel rebates and targeted support to hauliers that muted carbon-price pass-through while the budget absorbed the shock (AS24, 2022; OnTurtle, 2023). The broader lesson for Spain is compositional and planning-oriented: the hydrocarbon-excise base will shrink over time as EVs and heat pumps diffuse (the “vanishing base”), so medium-term plans should (i) *under-promise* on future excise receipts, (ii) coordinate excise schedules with forthcoming ETS2 allowance-price bands, and (iii) use the Social Climate Fund to replace blunt rebates with targeted, rules-based compensation—thereby stabilizing both public support and the fiscal contribution of carbon-related instruments (European Commission, 2024; Carbon Market Watch, 2024).

References:

- Akyüz, Y. (2007). *Debt sustainability in emerging markets: A critical appraisal*. United Nations Department of Economic and Social Affairs.
- Alesina, A., & Ardagna, S. (2010). *Large Changes in Fiscal Policy: Taxes versus Spending*. *Economic Policy / NBER WP*.
- Alesina, A., & Drazen, A. (1991). *Why are Stabilizations Delayed?* *American Economic Review*. (see also NBER versions).
- Auerbach, A., Gokhale, J., & Kotlikoff, L. (1994). *Generational accounting: A meaningful way to evaluate fiscal policy*. *Journal of Economic Perspectives*, 8(1), 73–94.
- Avgousti, A., Caprioli, F., Caracciolo, G., Cochard, M., Dallari, P., Delgado-Téllez, M., Domingues, J., Ferdinandusse, M., Filip, D., Nerlich, C., Prammer, D., Schmidt, K., & Theofilakou, A. (2023, revised June). *The climate change challenge and fiscal instruments and policies in the EU (Occasional Paper Series No. 315)*. European Central Bank.
- Ball, L., Furceri, D., Leigh, D., & Loungani, P. (2013). *The Distributional Effects of Fiscal Consolidation*. IMF Working Paper.
- Bank of England (2023). *Financial stability buy/sell tools: a gilt market case study*; and Pinter et al. (2023) *An anatomy of the 2022 gilt market crisis*.
- Bank of England. (2023). *Financial Stability Report*. London.
- Baumol, W. J., & Oates, W. E. (1988). *The Theory of Environmental Policy*. Cambridge University Press.
- Bianchi, F., & Melosi, L. (2017/2019). *The Dire Effects of the Lack of Monetary and Fiscal Coordination*. NBER WP / JME. NBER+I
- Bianchi, F., Faccini, R., & Melosi, L. (2022). *Inflation as a Fiscal Limit*. Jackson Hole Proceedings. Federal Reserve Bank of Kansas City
- Blanchard, O., Chouraqui, J., Hagemann, R., & Sartor, N. (1990). *The sustainability of fiscal policy*. OECD Economic Studies, 15.
- Bohn, H. (1998). *The behavior of U.S. public debt and deficits*. *Quarterly Journal of Economics*, 113(3), 949–963.
- Bohn, H. (2008). *The sustainability of fiscal policy in the United States*. In Neck & Sturm (eds.), *Sustainability of Public Debt*. MIT Press.
- Bovenberg, A. L., & de Mooij, R. (1994). *Environmental levies and distortionary taxation*. *American Economic Review*, 84(4), 1085–1089.
- Carbone, J. C., Morgenstern, R. D., Williams III, R. C., & Burtraw, D. (2013, August). *Deficit Reduction and Carbon Taxes: Budgetary, Economic, and Distributional Impacts*. *Resources for the Future*.
- CBO (Congressional Budget Office). (2022). *The 2022 Long-Term Budget Outlook*. Washington, D.C.
- Cebotari, A. et al. (2009). *Fiscal Risks: Sources, Disclosure, and Management*. IMF.
- Chalk, N. A., & Hemming, R. (2000). *Assessing fiscal sustainability in theory and practice (IMF Working Paper)*. International Monetary Fund.
- Coady, D., Parry, I., Le, N. P., & Shang, B. (2019). *Global Fossil Fuel Subsidies Remain Large: An Update Based on Country-Level Estimates*. IMF Working Paper.
- Cochrane, J. (2011). *Understanding policy in the Great Recession: Some unpleasant fiscal arithmetic*. *European Economic Review*, 55(1).
- Cochrane, J. H. (2022). *The Fiscal Roots of Inflation*. *Review of Economic Dynamics*. IDEAS/RePEc
- Council of the EU. (2024). *Economic Governance Reform*. Brussels.
- Council of the EU. (2024). *Economic governance review: Council adopts reform of fiscal rules*. Brussels.
- De Grauwe, P., & Ji, Y. (2013). *Self-fulfilling crises in the Eurozone*. *Journal of International Money and Finance*, 34, 15–36.

- Debrun, X., & Kinda, T. (2017). *Strengthening Post-Crisis Fiscal Credibility: Fiscal Councils on the Rise—A New Dataset*. Fiscal Studies. IDEAS/RePEc
- Douenne, T., & Fabre, A. (2020). *Yellow Vests, carbon tax aversion, and biased beliefs*. Ecological Economics, 167.
- Elshamy, H. M., & Ahmed, K. I. S. (2017). *Green Fiscal Reforms, Environment and Sustainable Development*. International Journal of Applied Economics, Finance and Accounting, 1(1), 48–52. <https://doi.org/10.33094/8.2017.11.48.52>
- European Commission (2024). *Ageing Report 2024*.
- European Commission (2024). *ETS2 for buildings and road transport: facts and timeline; and Decision on the 2027 cap (Dec. 3, 2024)*. Climate Action+1
- European Commission (2024). *Social Climate Fund—EU action (purpose and design for ETS2)*. Climate Action
- European Commission. (2013). *Report on Spain 2013*. Brussels.
- European Commission. (2013). *Report on Spain*. Brussels.
- European Commission. (2024). *EU ETS / ETS2 policy materials and implementation guidance (road transport and buildings)*. European Commission.
- European Commission. (2024). *The 2024 Ageing Report*. Brussels.
- European Parliament (2024a). *The new EU fiscal governance framework (IPOL IDA 760231)*. European Parliament
- European Parliament (2024b). *Assessing its use in the EU's new fiscal rules (IPOL STU 760273)*. European Parliament
- Featherstone, K. (2015). *External conditionality and the debt crisis: The 'Troika' and public administration reform in Greece*. Journal of European Public Policy, 22(3), 295–314.
- Gao, G., Li, X., Liu, X., & Dong, J. (2021). *Does air pollution impact fiscal sustainability? Evidence from Chinese cities*. Energies, 14, 7247. <https://doi.org/10.3390/en14217247>
- Gao, G., Li, X., & Dong, J. (2021). *Does air pollution impact fiscal sustainability? Evidence from Chinese cities*. Energies, 14(21), 7247.
- Goulder, L. H. (1995). *Environmental taxation and the double dividend: A reader's guide*. International Tax and Public Finance, 2(2), 157–183.
- Heindl, P., Löschel, A. (2015). *Social Implications of Green Growth Policies from the Perspective of Energy Sector Reform and its Impact on Households*. ZEW Discussion Papers, No. 15-012.
- Hewett, C., Ekins, P. (2014). *Environmental Fiscal Reform in Europe: An overview of policy and politics of implementing environmental fiscal reform in Europe between 1990 and 2013, working paper*, The Danish Ecological Council.
- Hilscher, J., Raviv, A., & Reis, R. (2022). *Inflating Away the Public Debt? An Empirical Assessment*. Review of Financial Studies. OUP Academic
- IMF & World Bank. (2001). *Debt Sustainability in Low-Income Countries: Proposals for an Operational Framework*. Washington, D.C.
- IMF (2017–2023). *RA-GAP methodology and country applications (e.g., Belgium, South Africa)*.
- IMF (2023). *Fiscal Monitor—Climate Crossroads: Fiscal Policies in a Warming World. (Ch. 1: fiscal/climate/political-feasibility trilemma)*.
- IMF (2023). *Fiscal Monitor—Climate Crossroads: Fiscal Policies in a Warming World. (Ch. 1: fiscal/climate/political-feasibility trilemma)*.
- IMF (2023). *Sovereign Risk and Debt Sustainability Analysis for Market-Access Countries (portal and materials)*. IMF
- IMF (2024). *Japan Article IV; Reuters (2025) on projected interest-cost surge*.
- IMF (May 2024). *Republic of Slovenia—Article IV Consultation: Staff Report/Press Release (growth, inflation, flood spending; fiscal path)*. IMF IMF eLibrary
- IMF. (2013). *Energy Subsidy Reform: Lessons and Implications*. International Monetary Fund.

- IMF. (2019). *Fiscal Monitor: Curbing Corruption*. Washington, D.C.
- IMF. (2021). *Staff Guidance Note on Public Debt Sustainability Analysis in Market-Access Countries*. Washington, D.C.
- IMF. (2021). *Staff Guidance Note on Public Debt Sustainability Analysis*. Washington, D.C.
- IMF. (2021). *Staff Guidance Note on Public Debt Sustainability Analysis in Market-Access Countries*. Washington, D.C.
- IMF. (2022). *Regional Economic Outlook: Sub-Saharan Africa*. Washington, D.C.
- IMF. (2023). *Fiscal Monitor—Climate Crossroads*. Washington, D.C.
- IMF. (2023). *Fiscal Monitor—Climate Crossroads: Fiscal Policies in a Warming World*. Washington, D.C.
- Kluza, K. (2016). Sustainability of local government sector debt: Evidence from Monte-Carlo simulations. *Lex localis – Journal of Local Self-Government*, 14, 115–132.
- Krugman, P. (1988). Financing vs. forgiving a debt overhang. *Journal of Development Economics*, 29(3), 253–268.
- Larch, M., & Turrini, A. (2010). The cyclically-adjusted budget balance in EU fiscal policy making. *Intereconomics*, 45(1), 48–60.
- Leeper, E. (1991). Equilibria under ‘active’ and ‘passive’ monetary and fiscal policies. *Journal of Monetary Economics*, 27(1).
- Lockwood, M. (2015). Fossil fuel subsidy reform, rent management and political fragmentation in developing countries. *New Political Economy*, 20(4), 475–494.
- López Subires, M. D., Alcaide Muñoz, L., Navarro Galera, A., & Rodríguez Bolívar, M. P. (2019). The influence of socio-demographic factors on financial sustainability of public services: A comparative analysis in regional governments and local governments. *Sustainability*, 11, 6008. <https://doi.org/10.3390/su11216008>
- Metcalf, G. (2009). Designing a carbon tax to reduce U.S. greenhouse gas emissions. *Review of Environmental Economics and Policy*, 3(1).
- Metcalf, G. (2019). *Paying for Pollution: Why a Carbon Tax is Good for America*. Oxford University Press.
- Metcalf, G. (2023). *The Macroeconomic Impact of Europe’s Carbon Taxes*. *AEJ: Macroeconomics*. American Economic Association
- Metcalf, G. E., & Stock, J. H. (2020). Measuring the Macroeconomic Impact of Carbon Taxes. *AEA Papers & Proceedings*, 110, 101–106. (context for growth/employment effects)
- Metcalf, Gilbert E., (2015). *A Conceptual Framework for Measuring the Effectiveness of Green Fiscal Reforms*. Prepared for the Green Growth Knowledge Platform Third Annual Conference on Fiscal Policies and the Green Economy Transition: Generating Knowledge – Creating Impact in Venice, Italy, January 29–30.
- Murray, B., & Rivers, N. (2015, November). British Columbia’s revenue-neutral carbon tax: A review of the latest “grand experiment” in environmental policy. *Energy Policy*, 86, 674–683. <https://doi.org/10.1016/j.enpol.2015.08.011>
- OECD. (2011). *Towards Green Growth*. OECD Publishing.
- OECD. (2017). *Investing in Climate, Investing in Growth*. OECD Publishing.
- OECD. (2017). *Investing in Climate, Investing in Growth*. OECD Publishing.
- OECD. (2019). *Taxing Energy Use 2019*. Paris.
- OECD. (2019). *Taxing energy use 2019: Using taxes for climate action*. OECD Publishing.
- Omolere, M. (2024, January 9). Carbon Tax: Definition, Pros and Cons, and Implementation. *Earth.org*; *Earth.org*. <https://earth.org/explainer-what-is-a-carbon-tax-pros-and-cons-and-implementation-around-the-world/>
- Ostry, J., Ghosh, A., Kim, J., & Qureshi, M. (2010). *Fiscal space*. IMF Staff Position Note SPN/10/11.
- OSW (2025) and WZB (2024) analyses on Germany’s *Schuldenbremse* debates.
- OSW (Centre for Eastern Studies). (2023). *Germany: the Constitutional Court deprives the government of €60 billion*.

Warsaw.

Parry, I. (2019). *Handbook of Environmental Economics*. Elsevier.

Parry, I., & Bento, A. (2001). Revenue recycling and the welfare effects of road pricing. *Scandinavian Journal of Economics*, 103(4).

Parry, I., Black, S., & Vernon, N. (2021). *Still Not Getting Energy Prices Right: A Global and Country Update*. IMF Working Paper.

Parry, I., Heine, D., Lis, E., & Li, S. (2014). *Getting Energy Prices Right: From Principle to Practice*. International Monetary Fund.

PEFA (2016, 2022). *Framework for assessing public financial management; stocktaking*.

Pigou, A. C. (1920). *The Economics of Welfare*. Macmillan.

Pinter, G., Theodoridis, K., & Yates, T. (2023). *An anatomy of the 2022 gilt market crisis*. Bank of England Staff Working Paper.

Porter, M. E., & van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives*, 9(4), 97–118.

Reinhart, C., & Rogoff, K. (2010). Growth in a time of debt. *American Economic Review: Papers & Proceedings*, 100(2), 573–578.

Reuters (2024). *Renewable energy produced a record 56% of Spain's electricity in 2024 (news report)*. Reuters

Reuters (2025). *Repsol to invest €800m+ in Tarragona green methanol plant; windfall tax ended (investment, policy link)*. Reuters

Rodríguez Bolívar, M., Navarro Galera, A., Alcaide Muñoz, L., & López Subires, M. D. (2016). Analyzing forces to the financial contribution of local governments to sustainable development. *Sustainability*, 8, 925. <https://doi.org/10.3390/su8090925>

Stern, N. (2007). *The Economics of Climate Change: The Stern Review*. Cambridge University Press.

Stiglitz, J. E., & Stern, N. (2017). *Report of the High-Level Commission on Carbon Prices*. World Bank.

Tax Foundation. (2025). *Carbon taxes in Europe: Spain (country profile / coverage)*. Tax Foundation.

UNEP. (2019). *Global Green New Deal*. United Nations Environment Programme.

Weitzman, M. (1974). Prices vs. quantities. *Review of Economic Studies*, 41(4), 477–491.

World Bank. (2021). *State and Trends of Carbon Pricing 2021*. World Bank.

World Bank. (2022). *Carbon Pricing Dashboard*. World Bank.

World Bank. (2022). *Debt Transparency in Developing Economies*. Washington, D.C.

World Bank. (2024). *State and trends of carbon pricing 2024*. World Bank

World Bank. (2024). *The Brazilian Pension System Under an Equity Lens*. Washington, D.C