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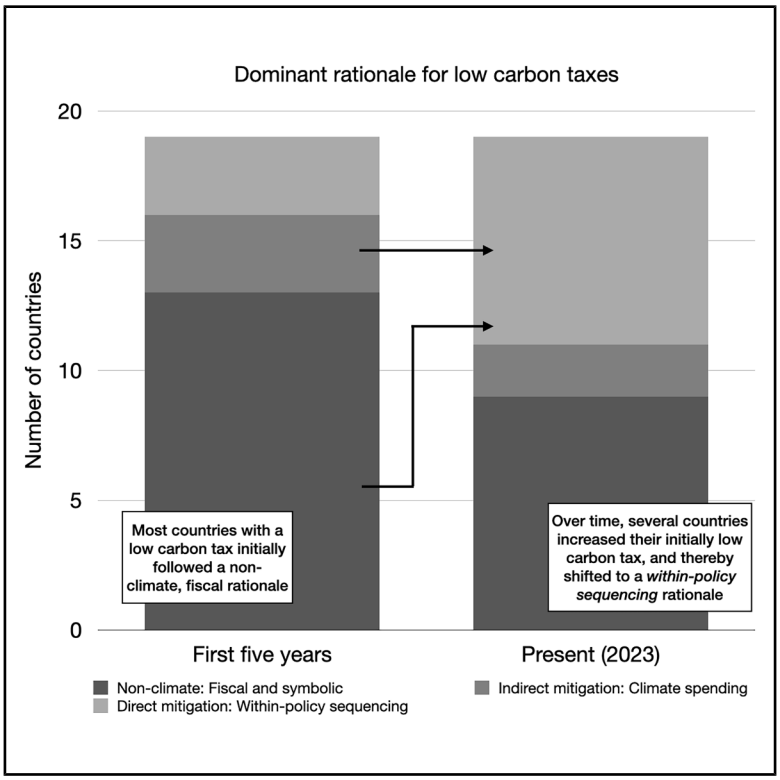
Article

Sequencing, spending, and symbolism: Low carbon taxes primarily serve purposes other than emissions reduction

Graphical abstract



Highlights

- We explore reasons why governments adopt low carbon taxes: what are they to achieve?
- We show that most low carbon taxes had non-climate-related aims
- Within-policy sequencing happened, but shift to higher carbon tax was often slow
- Within-policy sequencing an increasingly important rationale for initially low taxes

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In brief

Most governments have implemented low or very low carbon taxes, raising questions about the underlying rationales. Through an in-depth investigation of all national low carbon taxes worldwide, we show that most had primarily symbolic and fiscal aims. A few governments adopted initially low carbon taxes with the intention to raise them later, once opposition decreased; this within-policy sequencing approach has grown more relevant over time. Our findings underscore the complex political rationales behind carbon taxes, beyond their assumed mitigation purpose.

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Sequencing, spending, and symbolism: Low carbon taxes primarily serve purposes other than emissions reduction

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SCIENCE FOR SOCIETY Carbon taxes imposed on fossil fuels are widely considered a useful policy tool to reduce greenhouse gas emissions. However, to be effective, the tax must be high enough to motivate the switch to low-carbon alternatives. While 25 countries have national carbon taxes, most (19) were implemented at a level too low to effect change. Why do nations implement carbon taxes, if they know the tax is too low to reduce emissions? We show that most initially low carbon taxes did not mainly seek to lower emissions but primarily followed fiscal aims, such as raising funds for the general budget or funding tax reforms. In some countries, low carbon taxes were introduced to avoid opposition but were designed to increase later when taxed actors had had time to adapt, and opposition may be lower. A country "having a carbon tax" is thus not an indication of climate policy progress, and the increasing number of carbon pricing schemes is not in itself evidence of a successful climate policy instrument.

SUMMARY

Carbon taxation is generally viewed as a central climate policy instrument to decrease and eventually eliminate carbon emissions. In many countries, however, carbon taxes are set and are kept too low to strongly reduce emissions, suggesting that climate change mitigation may not be their primary rationale. We analyze the tax design, policy evolution, and governmental justification of each of the 19 initially low national carbon taxes implemented in 1990–2023. We show that several countries followed a *within-policy sequencing* rationale: an initially low carbon tax set to increase to emission-reducing levels later, but sometimes slowly, up to decades after implementation. Some taxes were designed to fund other climate policies. Most initially low carbon taxes primarily followed fiscal rationales or were implemented to meet international expectations. We conclude that the primary rationale or priority outcome for enacting carbon taxes is not always to reduce emissions.

INTRODUCTION

Carbon pricing, either in the form of a carbon tax or an emissions trading system (ETS), is widely seen as a key climate policy instrument to reduce and eventually eliminate greenhouse gas (GHG) emissions and achieve the temperature targets of the Paris Agreement.[1,2] Proponents state that carbon pricing is "essential for mitigating climate change"[3] because it incentivizes producers and consumers to reduce emissions where this is economically least costly.[4] Climate economists and several international organizations have been advocating the introduction of carbon pricing for decades and ever more countries are adopting it.[5] In 2023, 73 carbon pricing instruments existed, of which 25 were national carbon taxes.[6]

However, many countries have still not introduced a carbon tax and, importantly, many of those that have a tax have set the rate much too low compared with expert recommendations. Unsurprisingly, the rich empirical literature evaluating the effectiveness of carbon pricing in reducing emissions has highlighted low prices as a key limiting factor.[7–10] Understanding the explanatory factors of such low carbon taxes is a fundamental topic in climate policy research.

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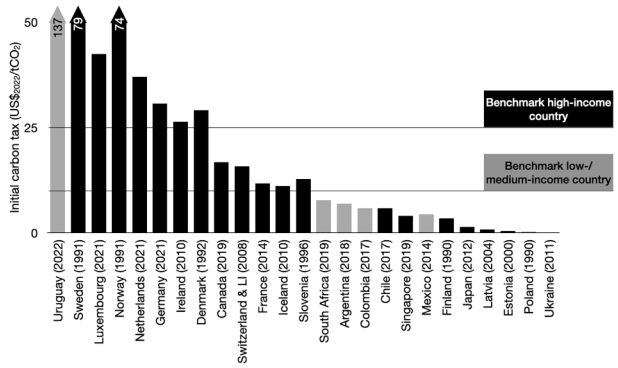

Figure 1. The carbon tax at implementation (and year of implementation) of all national carbon taxes existing in 2022

When multiple tax rates exist, we show values for transport fuels or gasoline. Blue bars are high-income countries, orange bars are low-/medium-income countries (based on the UN classification for 2022). The Uruguayan tax is above the scale. Spanish carbon tax not shown, as it applies only to fluorinated GHG. UK and Portuguese carbon taxes are excluded as they operate within an ETS, not as stand-alone taxes. Our study focuses on the cases initially below the benchmarks, i.e., Ireland and all countries to the right in the graph. Nominal prices, US$/tCO$_2$. Source: World Bank.[6]

Many proposals have been made regarding the appropriate carbon tax level; published estimates suggest that the lowest carbon tax expected to have a relevant emission-reducing effect is US$25– US$40/tCO$_2$ for 2020[11–13] for high-income countries and, because their mitigation options tend to be cheaper, around US$10/tCO$_2$ for low- and medium-income countries[14] (sources and details: Note S1). Because of this strong consensus in the scientific literature, we assume that governments know that a carbon tax below these benchmarks (US$25/tCO$_2$ for high-income and US$10/tCO$_2$ for low-/medium-income countries) will not directly meaningfully lower emissions without being substantially increased. For not only triggering a mentionable effect, but strongly contributing to meeting the Paris Agreement targets, essentially all authors and organizations recommend much higher carbon prices than these benchmarks—and recommend increasing carbon taxes over time, often going above US$100/tCO$_2$ by 2030.[15] This stands in stark contrast with actual carbon taxes: of the 25 countries with a national carbon tax (see Case selection and benchmarks), 19 were initially implemented at a level below these minimum benchmarks (Figure 1). Thus, most national carbon taxes were set too low to meaningfully reduce emissions, and the implementing governments must reasonably have known this.[16–18]

This raises a fundamental question: If policymakers can know that the low tax will hardly reduce emissions, what are initially low carbon taxes implemented to achieve? Several studies suggest that an initially unambitious version of a policy is conducive to increasing ambition later, as the initial stage will "sow the seeds of change"[19] and alter existing path-dependencies by generating coalitions to support strengthening the policy over time.[20,21] As it does not intrude much on incumbents and practices, a low tax faces less opposition and may be easier to implement. This way, an initially weak policy may follow a rationale of *within-policy sequencing*, seeking to ratchet up ambition later.[22] Within-policy sequencing is one particular and under-investigated case within the broader sequencing theory. Sequencing generally refers to sequencing *across policies*, such as an initial policy building support for expanding the ambition and breadth of the *overall policy mix* (e.g., renewable power support triggering green industry expansion, and these new actors demanding stronger action in further fields over time). There is much empirical evidence supporting cross-policy sequencing in climate policy,[20–23] including how renewable power support increases feasibility of broader-scope carbon pricing policy later on. There is some empirical evidence for within-policy sequencing (e.g., in the EU Emissions Trading Scheme, or within European renewable energy policies), but so far the evidence for (or against) within-policy sequencing remains relatively thin. In their analysis of potential sequencing in EU climate and energy policies, Leipprand et al. acknowledged that comparative case studies are needed to identify whether and how within-sequencing happens also for other policies.[24]

Moreover, climate politics research has broadened the analysis of carbon tax adoption, also going beyond the often-assumed goal of climate change mitigation. In several single-case studies and small-*n* comparisons, "the decision to pursue a carbon tax [has been shown to be] not primarily related to the reduction of GHG emissions"[25] but to other policy rationales, including meeting international expectations,[26,27] increasing state income, or financing tax reforms.[28] Whereas multi-case policy analyses of carbon taxation exist, these have focused on the factors that drive or hinder carbon tax adoption.[29–31] To date, no multi-case study has investigated the rationales of low carbon taxes beyond binary assessments of whether or not such a tax exists.

We address these gaps through a cross-country empirical analysis of the policy design, tax evolution, and expressed justification of all 19 national carbon taxes initially implemented below the relevant climate-effectiveness benchmark 1990–2023 (detailed country analyses in Note S2). We do not investigate the effectiveness of carbon pricing nor the underlying policy processes but explore and compare the policy output and stated aims of the taxes, to understand the rationales of these low carbon taxes the way they were implemented. Our results show that the rationale behind initially low carbon taxes was often not mainly to reduce emissions, but to generate tax revenues or meet international expectations. We also empirically test the *within-policy sequencing* hypothesis, showing that, within the first 5 years after adoption, the sequencing rationale was strong only in a handful of cases. We also show that several countries did increase their carbon taxes later on—sometimes strongly—showing that within-policy sequencing does happen, but such processes have been slow in the past, taking up to three decades. These findings highlight the importance of non-climate rationales of carbon taxation, confirming previous case studies. They also help explain why many carbon taxes are too low for rapid, substantial decarbonization: they were not primarily designed to do this.

RESULTS

Methods summary

We focus our analyses on low carbon taxes. While the classical purpose of a carbon tax is to reduce emissions, we specifically

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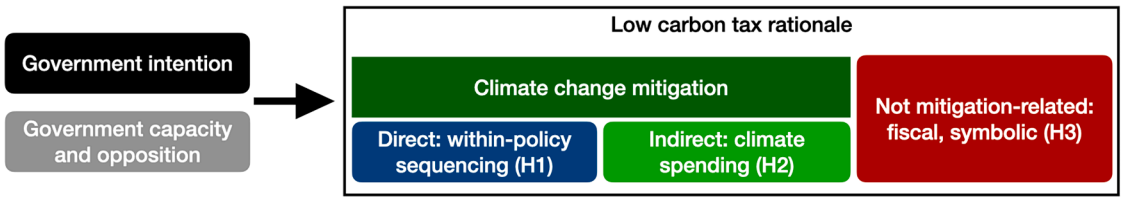

Figure 2. Ideal-typical rationales of initially low carbon taxes, as the observable outcome of original policy intention, capacity, and negotiations with political opposition

In this paper, we triangulate these rationales through observation of policy output, policy development over time, and government justifications of policies and reforms.

focus on taxes initially set so low that no government can expect them to mentionably reduce emissions. Although a *low* carbon tax cannot be expected to strongly reduce emissions without being reformed, it may still follow a climate-driven rationale, through two ideal-typical paths. If the carbon tax is set to increase over time, its main rationale may be to reduce emissions directly through guiding effect of the tax itself (*within-policy sequencing*[22,24]). Slowly phasing in the tax may have been the original plan to give regulated actors time to adapt, or possibly the government intended a higher tax but the initially low and then rising tax was a political compromise to make a carbon tax feasible at all[32,33] given the often strong opposition.[34,35] A low carbon tax may also reduce emissions *indirectly*, not mainly through the tax itself but through targeted spending of the carbon tax revenues on other climate policy measures that subsequently trigger emission reductions (*climate spending*).[36] As a carbon tax is technically indistinguishable from any other tax, it may also follow *non-climate rationales*, such as generating funds for the general budget or for lowering other taxes, e.g., income taxes. It may also serve symbolic purposes, such as building international reputation, qualifying for international funding, or responding to expectations of international organizations (e.g., during an OECD membership process), as shown among others by Rabbia for South American countries.[25,26] A low carbon tax could be attractive for such non-climate purposes,[25] because it does not strongly interfere with the economy, while still possibly raising meaningful funds or ticking boxes of "having a carbon tax" (details in the methods).

Corresponding to the ideal-typical rationales described above, we approach this along three hypotheses about national, low carbon tax implementation: was each of these taxes implemented mainly following a rationale of (1) within-policy sequencing or (2) climate spending, or (3) rather following mainly non-climate rationales? We seek support for each hypothesis based on primary and secondary documents on justification and instrument design, and on scientific case study literature (see below and in the methods). As our research question concerns the rationale of the low carbon tax as implemented, we first focus on the implementation decision and the first 5 years following the entry-into-force, and then complement this with an all-years analytical horizon, from entry-into-force to 2023.

We empirically investigate the stated justifications and policy designs of initially low carbon taxes to understand the rationales behind them. We do this in two ways: by observing how governments themselves justify the carbon taxes the way they were implemented and by observing the policy design, particularly tax level, coverage, and revenue earmarking, at the time of implementation and over time. The implemented policy—our object of analysis—may deviate from the government's original intent, particularly by being weakened by opposition and actors with other interests and aims during agenda setting and policy formulation[32,33,37] (Figure 2). We thus investigate the rationale of the policies *as implemented*, and do not examine the policy process and negotiations within governments or with opposition, which would be the task of dedicated deep case studies. Identifying the rationales of existing low carbon taxes, the way they exist in reality, after political bargaining, is important, both to understand why many carbon taxes remain low and to better understand the role of carbon taxation as a climate policy to help achieve the Paris Agreement targets. Note that we do not investigate the rationales of implementing a *high* carbon tax, which may follow a different logic than a low carbon tax. Further rationales than those we investigate here could justify the introduction of a carbon tax, such as the co-benefits of reducing air pollution. However, while such co-effects can serve as a justification for introducing a high carbon tax, it hardly justifies the implementation specifically of a *low* carbon tax, which would not be expected to significantly reduce emissions.

Overall trends in low carbon tax rationales

Of the 19 national carbon taxes implemented below the climate change mitigation-relevant benchmark level, three policies primarily followed a within-policy sequencing rationale in the 5-year time perspective (Switzerland, France, and Canada; Figure 3A, details below): they implemented an initially low carbon tax set to increase over time, and all three taxes exceeded the benchmark quickly. Three countries (Japan, Colombia, and Singapore) introduced a low tax mainly to collect funds for spending on other climate policy measures. The remaining 13 countries kept their carbon taxes low for the first 5 years and most of these kept it below the benchmark over time, sometimes without increasing it at all. These carbon taxes mainly follow a fiscal rationale, seeking to generate additional tax income for the general budget or specific other non-climate spending priorities such as health care, sometimes complemented by a symbolic rationale of fulfilling international expectations. This suggests that the most common primary rationale when *introducing* a low carbon tax was not to reduce emissions and meaningfully mitigate climate change.

In the full time-perspective, the findings are similar but with stronger support for the within-policy sequencing

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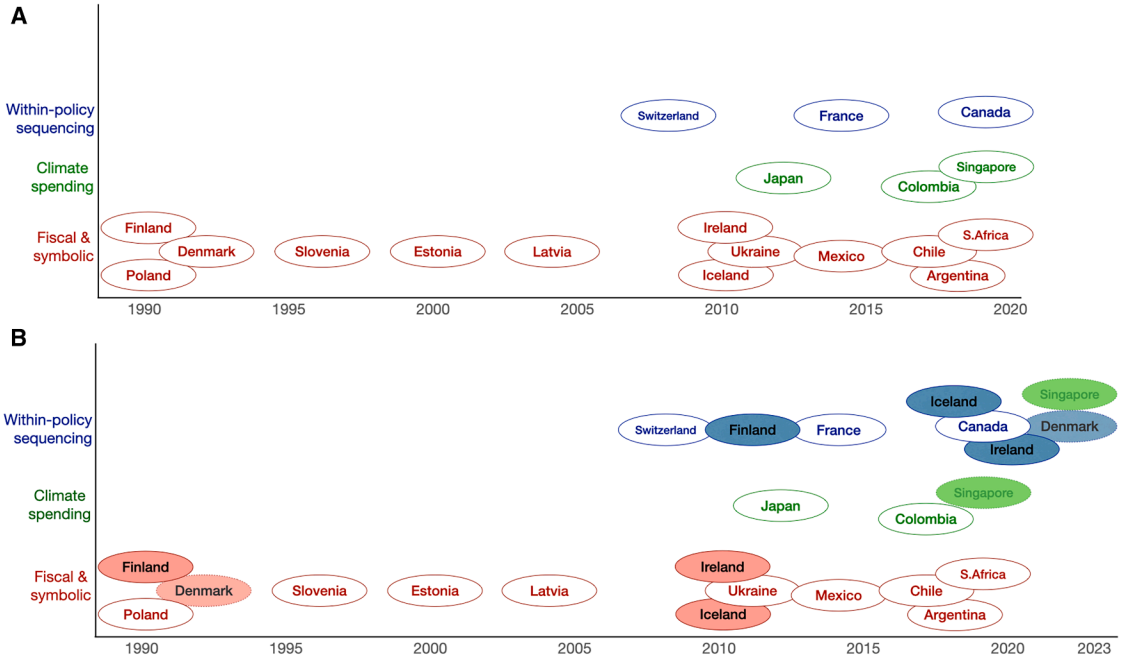

Figure 3. Summary of best-supported hypotheses for each of the 19 countries with an initially low carbon tax

(A) Implementation plus first 5 years, (B) all years to 2023. The shaded entries indicate countries that shifted approach after the first 5 years following implementation; these shifting countries appear again in the within-policy sequencing group in the year the approached changed. In 2022, Denmark and Singapore (dashed entries) decided policy reforms that, should they be implemented as decided, will meet the within-policy sequencing criteria in 2025 (Denmark) and 2026 (Singapore). See Note S2 for detailed country-by-country results, including sources and specific government statements, tax, revenue use, and coverage developments between tax implementation and 2023.

hypothesis: three further countries (Finland, Iceland, and Ireland) adapted their main policy rationale at a later point, 9–21 years after implementation, to add clear within-policy sequencing elements by increasing their taxes to above the benchmarks and introducing clear mitigation-related policy justifications (Figure 3B). In 2022, Denmark and Singapore decided to raise their taxes above the benchmarks by 2025 (33 years after implementation) and 2026 (7 years) but had not yet done so in 2023. All countries that shifted to a direct climate mitigation rationale went from a predominantly fiscal rationale, except Singapore, which rather appears to have added a direct mitigation component to its climate spending rationale. In the full-time perspective, 1990–2023, almost all countries meet the criteria for either the non-climate (9 of 19 cases) *or* the within-policy sequencing hypothesis (8 of 19).

All details and sources are found in the detailed country-by-country policy analyses in Note S2.

Within-policy sequencing

Three countries—Switzerland, France, and Canada—implemented their national carbon taxes primarily to reduce emissions through the tax itself and quickly increased the initially low carbon tax to above the benchmark (Figure 4A Note S2). These countries meet the criteria for the within-policy sequencing hypothesis: they implemented an initially low carbon tax, thereby circumnavigating prevailing opposition (including after previous failed implementation attempts) and giving the policy addressees time to adapt, with mechanisms to increase the tax to meaningful levels over time. They all refund taxpayers to incentivize emission reductions while minimizing economic and social impacts.

The initial Swiss carbon tax rate was reduced by two-thirds in parliamentary negotiations, but was set to escalate determined by emission reductions achieved in previous years: if emissions decreased too slowly, the tax was increased along a predefined schedule. It thus rapidly surpassed the originally proposed level, exceeding our benchmark (US$25/tCO$_2$ for high-income countries) after 2 years. The French and Canadian tax levels were informed by expert councils based on emission reduction aims, and set to increase along a predetermined schedule, initially planned to rise above US$100/tCO$_2$ by 2030 or before; the French tax escalation plan was halted by the Yellow Vest protests in 2018. The French tax was deliberately set low to avoid implementation problems after previous attempts had been canceled by the Constitutional Council. In all three cases, we find evidence of political bargaining during the decision process: all three adopted a lower tax than the governments proposed due to political opposition, but all held mechanisms to quickly ratchet up the carbon tax.

In 2023, generally long after first implementation, a further five countries met the criteria for the within-policy sequencing hypothesis. The Finnish carbon tax, which the government explicitly mention as following fiscal goals, was amended and increased in 2011 to also support its climate goals. In Iceland, the carbon tax was implemented to support the state budget during the global financial crisis, but was made permanent after the crisis. It was increased in 2018 to well above the benchmark to also incentivize emission reductions, while maintaining the

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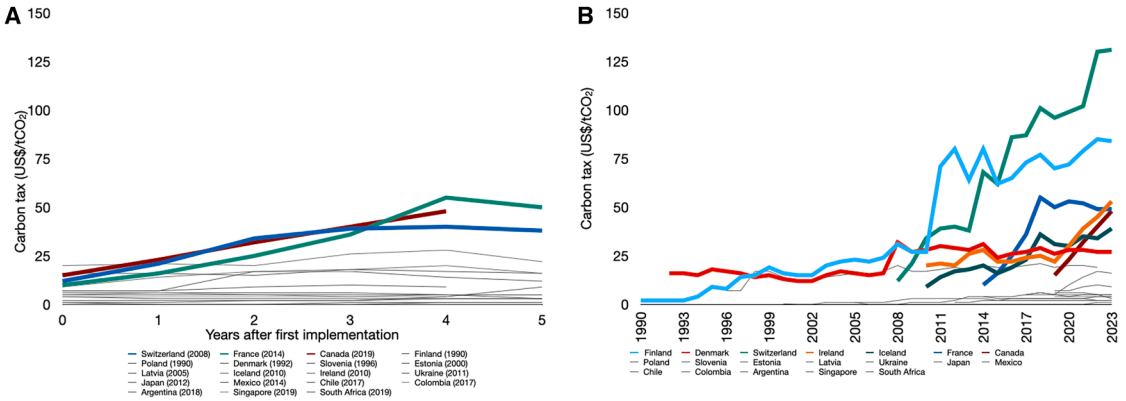

Figure 4. Carbon tax rate development in all countries that implemented a carbon tax initially lower than the benchmark levels

(A) During the first 5 years after implementation and (B) all years 1990–2023. Thick lines are the countries that mainly followed a within-policy sequencing rationale within each of the respective time perspectives; thin lines are all other countries. For countries with multiple tax levels (per sector or fuel), we show only the highest one. Fluctuations may be due to exchange rate changes, not policy changes; the Irish tax increase above the benchmark is solely due to EUR-US$ exchange rate changes, as is the decrease of the French tax in year five. Nominal prices (for deflated prices, see Note S3).

revenue-raising function for the general budget. Similarly, the Irish carbon tax was implemented to boost the state budget during the financial crisis. It was set to double 2010–2014, driven by the need to generate income, but the increases after 2012 were not implemented and the tax remained below the benchmark. In 2020, the Irish carbon tax was reformed to increase by a fixed rate per year, planned to reach US$117/tCO$_2$ by 2030; after this reform, the tax quickly surpassed the benchmark, with additional income earmarked to alleviate tax effects on vulnerable households. In Denmark and Singapore, the governments in 2022 decided to increase the carbon taxes strongly over the 2020s, to well above the benchmark levels, thereby—should these increases be implemented as decided—adding a clear direct mitigation rationale to their existing and still strong fiscal (Denmark) and spending (Singapore) rationales.

Because we do not investigate the policy process or the internal politics of each carbon tax system, we do not know which factors have changed to allow these countries to (presumably) shift rationale over time. We note, however, that this change corresponds well to the expected observation under within-policy sequencing: first implement an imperfect but politically feasible version of the policy, then let a coalition supporting it develop, and then, when this has increased political feasibility of a sharper policy, ratchet up ambition.

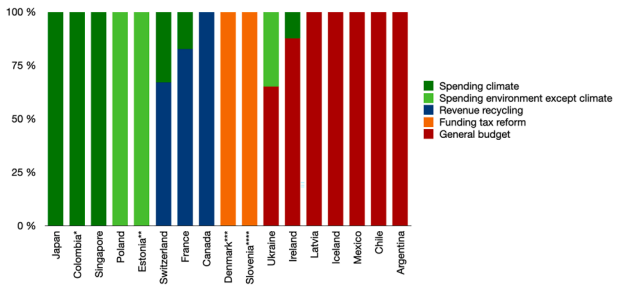

Figure 5. Revenue usage in the initial 5 years after implementation of the national carbon tax

*Colombia: varying revenue use, mainly climate-relevant environmental spending, notably forest protection, but also spending for the national peace process.

**Estonia: uncertain data—revenues directed to the Ministry for the Environment, likely for environmental spending.

***Denmark: only known for the first two years (1992–1993), later 45% tax shift, 47% general budget, 8% spending.

****Slovenia: revenues appear to have been repaid to tax payers through an ex-post lowering of the carbon tax payment for each company.

Finland and South Africa not shown. In Finland, all revenues go to the general budget, and were used to fund a green tax shift but we have no explicit quantitative data about the revenue usage split prior to 1998 (year 8 after implementation). The South African tax is used to lower the electricity tax, tax incentives for energy efficiency, and to subsidize energy consumption for low-income households, but we do not know the shares. See Note S2 for sources and details per country.

Climate spending

Three countries—Colombia, Japan, and Singapore—primarily used their low carbon taxes to fund other climate spending programs, and thus best support the climate spending hypothesis (Note S2). These countries' policies were characterized by low tax levels but broad tax bases, allowing them to raise substantial earmarked funds without being disruptive to the taxed actors (Figure 5). None of these policies held plans for future increases and the taxes have remained roughly constant. In both Japan and Singapore, initial government proposals for higher carbon taxes were either rejected or watered down by opposition; also these original proposals were far below the benchmark and did not hold within-policy sequencing elements.

In 2022, the Singaporean parliament decided to increase the carbon tax over the 2020s, starting in 2024 and reaching above the benchmark in 2026; if implemented as decided, this change will add a within-policy sequencing logic to the policy, seeking also to substantially reduce emissions directly through the tax, 7 years after initial implementation.

The Japanese and Singaporean revenues were earmarked for energy efficiency measures, both to reduce emissions and to help reduce the total carbon tax burden over time. In Colombia, the revenues were earmarked for various environmental

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protection projects, including climate-relevant ones (e.g., rainforest protection), historically also for the "Colombia in Peace Fund" supporting the domestic peace process. Poland and Estonia used their small (US$1–US$3 million/year) carbon tax revenues for environmental protection measures but, due to the very small revenues and non-climate spending focus, they do not meet spending hypothesis criteria.

Non-climate rationales

Most countries—13 of 19—did not primarily follow a climate-related rationale with their low carbon tax implementations in the first 5 years, but used the carbon taxes to raise funds for specific non-climate expenditures (e.g., education, Chile) or for general fiscal reasons, either to finance a tax reform (e.g., lowered income taxes, Finland) or increase state income (e.g., Iceland and Ireland). Some countries also implemented a carbon tax due to external pressure to support their integration in international organizations recommending this (e.g., Chile and Argentina, for their OECD memberships).

Most carbon taxes in this group primarily followed fiscal rationales. The early adopters Denmark and Finland implemented their carbon taxes as parts of general tax system reforms, seeking to maintain tax income while lowering income taxes. Such green tax shifts were important across the Nordic countries, including Sweden (which adopted an initially *high* carbon tax in 1991[38]): although climate considerations existed, the income tax reform was the main driver.[39] Finland in 2011 added a within-policy sequencing rationale, with explicit government references that the tax is expected to directly reduce emissions in addition to the still strong fiscal rationale; the same was decided in Denmark in 2022, although the tax had not yet increased above the benchmark in 2023.

In other countries, the carbon tax was implemented to generate state income. In Iceland and Ireland, this was done explicitly to help stabilize the state budget following the Global Financial Crisis. The Irish government initially planned an income-neutral carbon tax, but was obliged to use it for increasing the tax base by the *Troika*, the group managing the country bailouts during the European debt crisis. In Iceland, the government planned a temporary income-generating carbon tax during the crisis, which it subsequently made permanent. Both countries eventually (after 10 [Ireland] and 8 years [Iceland]) shifted their rationale, moving to a direct mitigation rationale to reduce emissions through the guiding effect of the tax.

In Chile, the carbon tax was explicitly dedicated to funding education and health programs, whereas the Argentinian carbon tax funded social and infrastructure programs. Both Chile and Argentina also implemented their carbon taxes to meet expectations of international organizations, especially preparing for their OECD membership processes. In both cases, the reputational benefits of having a green tax "for the sake of having one" seems a central factor to explain the low level and adoption timing of the carbon taxes.[25]

For some Eastern European countries (Poland, Slovenia, Estonia, and Ukraine), we could not access primary sources on revenue use or government policy justifications from the time of implementation but only for later years. For all these cases, we found no indication of specifically climate-related spending of revenues.

DISCUSSION

Our results show that, in the first years after implementation, most initially low national carbon taxes primarily followed non-climate rationales: generating revenue for the general budget, sometimes to fund a general tax system reform or dedicated non-climate spending, while sometimes also fulfilling symbolic rationales stemming from international expectations. Twelve of the 19 countries with an initially low carbon tax still had carbon taxes below the benchmark levels in 2023, and many maintained substantial exemptions from tax eligibility. This indicates that, for many carbon taxes, the ways they were implemented were not primarily or at all designed to reduce emissions. Of the 25 national carbon tax systems that exist, almost half of the taxes remained below the threshold for mentionably affecting emissions, also after several initially low carbon taxes had been ratcheted up.

The within-policy sequencing approach—start with a low but politically feasible tax and increase it later when supportive coalitions are stronger and reforms more feasible—could be observed within the first 5 years after implementation in only three cases (Switzerland, France, and Canada). This shows that within-policy sequencing was not a dominant rationale in the early phases of the investigated cases. However, five further countries (Finland, Iceland, and Ireland, and from 2025/2026 likely also Denmark and Singapore) added a direct mitigation rationale to their existing carbon tax policies, often many years after their implementation. In this full-time perspective, non-climate fiscal and symbolic rationale and the within-policy rationale are about equally frequent. This shows that within-policy sequencing sometimes happens, but it can be slow, supporting previous findings, for example, of Pahle et al., who identified *cross-policy sequencing* (renewables support to carbon pricing) unfolding over more than a decade.[22] Only two countries (Switzerland and Finland) with initially low taxes have achieved "high" carbon taxes somehow within the range stated as compatible with 2030 climate targets.

Our observations cast doubt on whether carbon taxes should always be viewed as climate policies: just as climate policy does not necessarily equal carbon pricing, carbon pricing is not always primarily a policy to reduce emissions but rather, for example, a fiscal policy. A country having a carbon tax is not in itself an indication of climate policy progress, and the increasing number of carbon pricing schemes is not in itself evidence of carbon pricing being a successful climate policy instrument.

Funding other climate policies was an uncommon main rationale for low carbon taxes but existed in three countries. Often, this revenue spending was spread into many small pots across numerous sectors. This is likely an indication of the political challenges associated with implementing even a low carbon tax, which requires political actors to consider the interests of numerous stakeholders, including through dedicated spending for their benefit.[40] The resulting low funding per spending area suggests that the climate spending may not be only directed to triggering substantial emission reductions but also as "pork" to buy acceptance of key stakeholders. Paying attention to the interests of multiple stakeholder groups to create pro-policy coalitions is central under both cross- and within-policy sequencing,[20,41] and we likely see it in spending policy designs too.

We observe geographical clustering of justifications and approach of initially low carbon tax adoption, suggesting that emulating neighboring countries was important. Clustering has been identified in previous research and explained by different polities[29,31] or closely linked trading partnerships,[30] which often coincide with geographical proximity.[3] We also identify "approach clusters" among neighbor countries, such as the Nordic carbon taxes supporting green tax shifts implemented in the early 1990s, or Latin American countries' almost identically low carbon taxes in 2017–2019, funding social programs and meeting expectations of international organizations. This suggests that countries influence each other—the likelihood of a country implementing a carbon tax increases when a partner country does so, as does the likelihood that they are similarly designed, and some governmental justifications refer to neighboring countries' tax implementations. However, we found no indication that implementing a low carbon tax to encourage other countries to do so as well was an important motivation. Further research, including in fields other than carbon taxation, is needed to better understand patterns of how such policy design clustering happens. Yet, our finding aligns with previous research suggesting that emulation has been a driver of carbon pricing (taxes and ETS) adoption: that governments look to other countries, asking whether it is "normatively appropriate" to adopt a carbon tax, but not "has the policy been successful."[42]

We see our research as making three main contributions to the literature. First, our findings complement the environmental economics literature on carbon pricing, which typically views it exclusively as a climate policy instrument, designed to internalize the carbon externality and incentivize emissions reductions.[43] Our findings add important evidence to explaining the often weak observed effects of carbon taxes on emission reductions of generally less than 1% per year[7,10,44]: reducing emissions was often not the primary rationale of carbon taxes in the real world.

Second, our findings support and align with previous research showing the importance of non-climate rationales of carbon taxation in single case studies.[25,26] Our findings add to the case-based literature investigating the policy processes of carbon price implementation by showing in a multi-country perspective that non-climate rationales are common among countries that adopt initially low carbon taxes.

Third, we show that within-policy sequencing does occur among some countries with initially low carbon taxes, but in the past this process has often been slow, sometimes unfolding over several decades. This does not mean that sequencing must necessarily proceed at such a slow pace or will continue to do so in the future; however, it does indicate that shifts in policy rationale—whether because the political climate evolves gradually or other reasons—can take considerable time. When the political context does shift, however, ratcheting up an existing tax may proceed more quickly than introducing a high tax from scratch.

Notably, we did not explore the role of the carbon taxes in the broader policy mix, including whether and how the (initially) unambitious taxes interacted with other instruments (e.g., support schemes and standards), but only how the taxes themselves and the rationales they followed evolved over time. Further in-depth case study research is needed to better understand the processes and the specific factors triggering or hindering both within- and cross-policy sequencing.

Whereas we see these findings as robust, our study has some limitations. First, we lack primary data and especially explicit government justifications for some early adopter countries in the 1990s, and especially for Eastern Europe. For these countries, we analyze the policy design development, which generally allows for unambiguous findings as most of these particular taxes remained very low. Nevertheless, further in-depth research about these cases is needed. Generally, there is very little research about carbon taxes outside northern/western Europe or North America[44]—especially for Eastern Europe—which is a serious gap, not only for our study.

Second, we analyze initially low, national carbon taxes, meaning that our results do not explicitly relate to emissions trading, to subnational carbon taxes, or to countries that implemented high carbon taxes above the benchmark, such as Sweden or Germany. Due to the guaranteed revenues, countries following a fiscal rationale possibly implement a tax rather than emissions trading, which would limit the transferability of our tax-related findings to cap-and-trade schemes. We call on further studies to investigate the rationales behind ETSs, including the rationale for the choice against a carbon tax, but also continued work to contrast the rationales of low and high carbon taxes.

Third, we investigate the policy output—the carbon taxes as implemented, including the government justifications for these. We do not investigate government intent, because we only triangulate the rationale of the policy as it exists, *after* the political negotiation process, through observation of policy design and written justifications. Importantly, we do not investigate the political negotiation process (including *within* the government, which is not a unitary actor), which certainly does affect the final policy design. We found evidence of several initial proposals being watered down during the political process (e.g., in Switzerland, France, and Argentina) but did not systematically investigate the internal processes. This would require in-depth analyses of each country, including interviews and process tracing, which is far beyond feasible for a 19-case comparative analysis. Yet, it would be highly valuable, such as already done for Latin American countries.[25]

The increasing number of countries implementing carbon pricing systems is in principle good news, indicating that climate protection exists on political agendas across the world. However, the mere existence of these instruments reveals little about their potential for facilitating a rapid transition to net-zero emissions as they may be designed for other purposes. If the primary rationale of a carbon tax is not directly related to climate action, these taxes may remain low for many years still, and countries may hide behind "we have a carbon tax" and further postpone more ambitious, urgently needed transformative climate policies.

METHODS

Case selection and benchmarks

We investigate the rationale of initially low carbon taxes, the way they were implemented, and thus only assess countries that adopted a national carbon tax below "too low to be climate-effective" benchmarks. We make no further selection: we include every country meeting this criterion.

Based on estimates from the literature (details in Note S1), we set the benchmark at US$25/tCO$_2$ for high-income and US$10/tCO$_2$ for emerging and developing countries. This benchmark is the minimum "meaningful tax" for possibly triggering notable emission reductions we could find in the academic and gray literature, although many authors see this lower limit considerably higher.[1,2,11,12,14,45,46] The benchmark is lower in low-/medium- than in high-income countries, because they often have higher potential for low-cost abatement, and because a US$1 investment in a poorer country tends to have a higher effect than in a richer one. These benchmarks are a key assumption in our analysis: because no analysis suggests below-benchmark taxes will be effective, no government implementing such a carbon tax can reasonably expect it to have a mentionable direct effect on emissions. For a detailed argumentation about the benchmarks, why we set them at this exact level, and effects of setting them differently, see Note S1.

These benchmarks apply to each national carbon tax at first implementation, regardless of implementation year. All countries meeting this criterion are high-income countries, except South Africa, Colombia, Argentina, Mexico, and Ukraine. We only investigate carbon taxes that existed in 2022, excluding previously canceled or future announced systems, but including the Slovenian carbon tax that was subsequently paused in 2023.[47] Because we investigate the rationales behind *low* carbon taxes, we exclude all countries with an initial tax above the benchmark; our case selection is independent of national climate targets or Paris pledges, and only considers carbon tax policies the way they were adopted.

We use the nominal carbon tax, because this is the tax the policy addressees see and may respond to. Some authors suggest using a weighted carbon tax (nominal level times coverage),[48] which we do not believe is useful here, for two reasons. First, actors can only respond to the tax applying to them, and as no actor is affected by a total-economy "average weighted" tax, this metric bears little meaning for the addressees.[8] Second, the coverage is already accounted for in our analysis, with high coverage as an indication for the climate spending hypotheses, and "few exemptions" being supportive of the within-policy sequencing hypothesis (see below).

Several countries have multiple carbon tax levels, often differentiated per sector and sometimes per fuel. Whenever a country has multiple tax levels, we base our analysis on the highest one, to avoid underestimating the tax level. The case studies report all levels, focusing particularly on the highest, whereas all figures show only the highest tax per country.

We limit our study to carbon tax systems because the tax level is directly decided by the government, whereas it is not directly decided in emissions trading. Consequentially, we exclude the Portuguese carbon tax and the UK carbon floor price—which would otherwise be in scope—because both depend on the EU ETS price.[49,50] Some taxes were designed to approximate EU ETS prices at some time (e.g., Ireland), but as especially the price trajectories were decided by governments, we include them.

We note that within-policy sequencing mechanisms are built in to some emissions trading schemes, including the EU ETS, the Californian system and RGGI, which hold mechanisms to adjust the allowance supply depending on the price trajectory. However, these systems are substantially different than carbon taxes and are not in our scope; they require specific investigation together with other ETSs.

We focus only on national carbon taxes and exclude subnational ones (e.g., in Canada), because they are often connected to national policies and are not entirely independent policies. We exclude the Spanish carbon tax because it applies only to fluorinated GHG emissions and Liechtenstein's carbon tax because it is *de facto* the Swiss carbon tax. Finally, we exclude Luxembourg's carbon tax, implemented in 2021, because the tax on transport fuels started above the benchmark (€31.6/tCO$_2$, US $37/tCO$_2$), although the tax for heating fuels started below the benchmark (€20/tCO$_2$, US$23/tCO$_2$).[6] The remaining 19 countries with an initially low national carbon tax are shown in Figure 1.

Empirical approach

We investigate carbon taxes that were introduced with such low taxes that the governments can know they will not have large effects on emissions: What was the primary rationale of these low carbon taxes, the way they were implemented? We observe these rationales in two ways: by observing government policy and reform justifications and by observing the tax design and its evolution.

First, we observe how a government justifies the low carbon tax, including stated aims, the way it was implemented. This may correspond to the original government intent, but may also be a reduced-ambition version of the originally intended policy, watered down or changed by political negotiations and opposition[33] and thus quite distant from original government intentions. We do *not* identify government intent in this article, but we do infer what the rationale of the policy was, the way it existed after the political bargaining process. Whenever we have data on the original government proposal or negotiation outcomes, we report and discuss it.

Second, we observe the policy design, particularly tax level, coverage, and revenue use. This way, we triangulate the rationale of the tax the way it was implemented by comparing the design and justifications to the criteria underlying three ideal-typical hypotheses (see below). We identify the main rationale of each tax, but a country may also follow several rationales or follow one dominant rationale with elements of another. Our analysis allows for a country to switch rationale or include additional elements over time.

We thus examine the rationale of the policy output, but we do not investigate the policy process of *how* the taxes came to be. Empirically examining the political bargaining behind the policy formulation (e.g., through interviews, process tracing) for each country over several years would be unfeasible for a 19-case article. Our key contribution to the literature is thus not the in-depth case study, but the identification and comparison of low carbon tax rationales in *all* national low tax cases.

We only consider decided policy changes, but not "announcements" of future changes, which may or may not materialize. However, we include policy changes that have been decided by parliament, even if they have not yet been implemented and may in principle still be revoked.

We investigate the initial implementation and the first 5 years of policy development, as we are particularly interested in the rationale of *adopting* a low carbon tax. The 5 years are an

estimate, albeit it not an arbitrary one: 10 or 15 years would certainly be too long to describe "the initial phase after implementation," but we could also have chosen 3 or 6 years, and it would have had no effect on our findings. As we also explore the proposition of within-policy sequencing, and cross-policy sequencing has been show to unfold over a decade or more,[22] we also look beyond the first 5 years (all years up to 2023), allowing us to also identify longer-term rationale shifts.

Ideal-typical rationales for initially low carbon taxes

We develop three ideal-typical rationales and formulate corresponding hypotheses.

The first rationale concerns within-policy sequencing, in which a carbon tax is initially low but then rises to more meaningful levels so as to directly reduce emissions through the guiding effect of the tax itself. Carbon taxation is typically viewed as an instrument for reducing emissions through the guiding effect of the tax.[1,51] However, in our cases with low carbon taxes, below the benchmarks, this effect cannot be expected: for substantial direct mitigation to happen, initially low carbon taxes must be increased.

Policy sequencing exists both within and across policies,[24] resting on the idea that policy is path dependent, so that initial policies may alleviate political barriers and trigger positive feedback, making subsequent reforms easier. Commonly, the term *sequencing* refers to cross-policy feedback. In this, successful implementation of a policy in one field creates coalitions supporting stricter policies in the broader policy field. This way, initial progress from an in itself insufficiently ambitious and/or sectorally narrow but early policy would increase the feasibility of tightening the entire policy mix, including the implementation of further policy instruments, such as higher taxes, new regulations or standards, quotas or subsides, to expand and accelerate decarbonization efforts throughout the economy.[20,21,24,52] For example, it has been shown that initial renewable energy support policies helped reduce mitigation costs *and* to generate coalitions supporting further and broader climate policies, such as carbon pricing.[21,24]

More relevant for our research question is *within-policy sequencing*,[24] which suggests a stepwise policy approach where "each stage is conducive to achieving the subsequent, more stringent one"[22] within *the same* policy. If a policy, even an unambitious one, is implemented, it will generate economic interests and supporters, who will then have a growing voice in subsequent reforms of that instrument.[22,53,54] Implementing an initially imperfect policy version—including if this imperfection is the outcome of political opposition and bargaining—would lower barriers to subsequent stricter implementation.[24] Starting with a low carbon tax is politically easier and may reduce opposition by giving industry and consumers time to adapt to the new pricing system,[55] and by first letting other policies lower the costs of new technologies.[21,56] *Ratcheting up* can be done ad-hoc when the opportunity arises, or systematically along a predefined escalation schedule or rules-based mechanism to increase the tax.[13,56] Further, recycling carbon tax revenues of a high carbon tax, with potentially large effects on the economy, back to citizens or companies on a per-capita/company basis may help reduce opposition[57] in a textbook-conform way while keeping mitigation incentives high, although real-world revenue recycling has had limited acceptance effects.[58]

There are several examples of sequential policymaking, notably the Paris Agreement with its repeated rounds of increasingly stringent national pledges, which "creates a case for governments to develop policy sequences that allow for continued decarbonization in future rounds of policy commitments and helps avoid a political, economic, and environmental dead end."[21]The EU ETS, the world's largest carbon pricing scheme, has clear within-policy sequencing mechanisms; for example, it held an initially intentionally weak design (2005–2007) to get the system started and gain experience before increasing the ambition on several occasions, especially between pre-defined trading periods.[24,53,56,59] Within-policy sequencing may thus be an option also for carbon taxes, as a mechanism to first make the carbon tax implementation politically feasible through a low tax level and then ratchet up ambition once the instrument exists and supportive coalitions have formed.

A second rationale of a low carbon tax is climate spending, or indirect climate change mitigation: the low carbon tax generates revenues that are used to fund other climate policy measures.[1,36,53,60] With large sectoral coverage, even a low carbon tax can generate substantial funds for other climate policies.[13,56,61] As countries move from old emission reduction targets to new, Paris-compliant net-zero carbon targets, the challenge grows: a zero-carbon energy system requires fundamentally new energy technologies, often with new or substantially adapted infrastructure.[62] This will require large investments, including public policies to support these investments, both in R&D and especially in infrastructure and market introduction support for still expensive but necessary technologies.[36,63] Raising such funds through a carbon tax is a polluter-pays-conform way to finance effective but possibly expensive climate policies without burdening the general budget, thus supporting climate policy acceptance.[55,64] Here, emission reductions are *indirect* effects of the tax: not the guiding effect of the tax itself would reduce emissions, but the investments triggered by other policies funded by earmarked carbon tax revenues.

A third rationale of low carbon taxes is not climate related, but rather follows symbolic or fiscal logics instead of primarily reducing emissions. We consider all non-climate rationales jointly, because they are more easily distinguished from climate mitigation rationales than from each other.

First, the carbon tax can be designed to serve fiscal purposes, such as increasing the general tax base or funding a green tax shift (e.g., reduce income taxes while keeping tax income constant through the new carbon tax). Then the rationale is not primarily connected with reducing emissions, but with generating new state income. Second, the carbon tax can be symbolic, sending a signal to national and international audiences, demonstrating the government's climate change mitigation commitment.[25,53] Furthermore, having a carbon tax could be beneficial (or explicitly required) for countries in the process of joining international organizations calling for certain environmental policies (e.g., OECD), or for receiving development aid or climate finance from international institutions such as the World Bank.[28] Hence, countries may also "have a carbon tax in order to have a carbon tax." Further, governments may implement carbon pricing to reduce the risk of exports becoming subject to future carbon border adjustment mechanisms, such as the coming EU CBAM. To avoid trade complications, having a low carbon tax

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Table 1. Overview of hypotheses and evaluation criteria for primary rationales underlying initially low national carbon taxes in the way they were implemented

Hypothesis Criterion	Mainly within-policy sequencing (H1) (direct climate change mitigation rationale)	Mainly climate spending (H2) (indirect climate change mitigation rationale)	Mainly not climate policy (H3) (symbolic or fiscal rationale)
Tax development and coverage	decided to increase above the benchmark at the time of implementation, or it did rise above the benchmark initial tax mainly based on expected emissions reduction to be achieved no or few exemptions within the regulated sector(s)	no or small tax increases decided; actual and planned tax remained below the benchmark level initial tax set based on revenue generation for climate spending high sectoral coverage to generate substantial revenues	no or only unsubstantial tax increases decided; tax remained below benchmark initial tax set based on not climate change-related aspects (e.g., fiscal consolidation, general tax reform) low coverage and/or substantial exemptions for "vulnerable" industries
Revenue use	most or all revenues recycled to balance cost increases for consumers and/or firms	most or all revenues earmarked for climate spending	not earmarked for climate-related measures
Specific government references	explicit references to substantial or main share of expected GHG emissions reduction triggered directly by the increasing carbon tax	explicit references to the necessity/importance of additional funding for climate spending	explicit references to international aspects (e.g., membership in organizations) explicit references to other not climate-related matters (e.g., fiscal consolidation)

may be better than not having one at all[65]: the point is *having* the instrument, and a low carbon tax is easier to implement and affects the economy less than a high one. Analogous to the EU CBAM, countries may in principle also implement a carbon tax to signal to its trading partners that they, too, should do so; for this, however, a low carbon tax will likely be of little use, hardly impressing partners.

Finally, governments may also use a non-effective carbon tax to fend off other, more stringent climate policies. This *Trojan Horse* strategy suggests that introducing a low carbon tax demonstrates willingness for climate protection, while diverting attention and resources from more effective measures.[66]

Hypotheses and evaluation criteria

If a country implements a carbon tax that is so low that it is unlikely to substantially reduce carbon emissions, then we hypothesize that it follows one or several ideal-typical rationales:

(H1) to introduce the instrument with a decided plan to gradually increase the carbon tax to more mitigation-effective levels in the following years (within-policy sequencing) as a main tool to directly reduce (sectoral) emissions; or

(H2) to generate revenues for the funding of other climate policies (climate spending), indirectly reducing emissions; or

(H3) for reasons other than climate policy, such as generating revenues for specific non-climate measures (fiscal policy) or sending a signal of their willingness to integrate into international organizations or to act on climate change (symbolism).

To support or reject the hypotheses, we explore how governments justify the tax the way it was implemented, and by observing the policy design, particularly tax level, coverage, and revenue usage. We gather evidence along different criteria (Table 1): each criterion alone is insufficient to support/reject a hypothesis, but the combination and pattern of supported/rejected criteria is sufficient. As countries may follow multiple rationales, the hypotheses are not necessarily mutually exclusive, and can show that a country's initially low carbon tax *primarily* follows one rationale while *also* including elements of another.

The main evaluation criteria for the within-policy sequencing hypothesis (H1) concerns the actual and planned tax level increases. Under this hypothesis, the initially low carbon tax increases to above the benchmark over time, thereby incentivizing addressed actors to reduce emissions. The tax is initially low to avoid political opposition, reduce economic disturbance and give actors time to adapt, or because it was watered down during negotiations. But because the carbon tax is meant to reduce emissions *directly*, the (eventual) tax level is based on estimated emission reduction effects, with few or no exemptions in the regulated sector(s). The coverage may be large or small, but exemptions within regulated sectors are small, because the central rationale is to incentivize emission reductions among the regulated actors (so not every sector must be taxed). The government makes explicit references to expected emission reductions triggered by the tax. Because the rising tax will cause substantial costs, recycling revenues back to policy addressees may be a dominant revenue use to increase policy acceptance. The key design observation is whether the initially low carbon tax has or is decided to increase over the benchmark level: if not, we deem statements about direct emission reductions through the tax non-credible.

The main evaluation criteria for the climate spending hypothesis (H2) refers to the revenue use and earmarking. Here, governments implement a low carbon tax as a politically feasible way to generate revenues for other climate measures. The carbon tax is an *indirect* climate policy: it is an important part of the policy mix, but other instruments funded by the carbon tax are the immediate emission reduction triggers. Schemes following this

approach are characterized by a consistently low tax, set to be non-disruptive to taxed actors, but with high coverage to ensure substantial revenues. The tax level is driven by the financing needs of the supported climate policies. The key design observations are that revenues are earmarked for climate measures and that the carbon tax does not increase above the benchmark levels, as direct mitigation is not the main policy rationale.

The main evaluation criteria for the non-climate policy hypothesis (H3) refer to the consistently low carbon tax, but also to specific government statements of the rationale of the instrument as implemented. Under this hypothesis, the low carbon tax is not primarily related to climate protection, but designed to raise funds for the general budget, finance tax reforms, meet international expectations, or for other non-climate reasons. The government explicitly justifies the carbon tax with such non-climate arguments, possibly flanked by secondary climate-related arguments. A key observation is the tax level, which remains below the benchmark and unconnected to climate ambitions. If the government knows a low tax will not mentionably reduce emissions, and still implements and maintains this low tax, then this indicates that the tax follows another rationale. This alone is, however, not proof of a non-climate rationale. If the carbon tax is mainly a fiscal policy, then revenues are *not* earmarked for climate spending or for revenue recycling, but necessarily go to the general budget or are earmarked for fiscal purposes, such as a green tax shift, or funding other government programs. A further strong indication is government justifications explicitly referring to these non-climate policy issues and, if applicable, to external requirements, such as recommendations or demands from international organizations. Large exemptions and/or low coverage are possible, if this still allows for sufficient revenue collection, because the main rationale is not to trigger emission reductions, but to generate tax revenue without upsetting the regulated actors.

Data sources

For the policy design analysis, we use data on tax level, revenue, and coverage, both from national (primary) sources and from the World Bank's Carbon Pricing Dashboard.[6] All statements of tax levels in US$ are those from the World Bank, converted from national currencies with the exchange rate applicable in the relevant year. Sometimes, carbon taxes appear to change because of exchange rate fluctuations but remain constant in national currency. Hence, the US$ cost figures are illustrative, bringing all taxes to a roughly comparable basis, rather than exact statements. All monetary statements are nominal prices (see Note S3 for analyses with real prices; our conclusions are not affected in the real-price perspective).

For the analysis of government justifications, we analyzed the official documents proposing, introducing or reforming each carbon tax system, e.g., laws, regulations, and other government documents. We particularly seek justifications of each carbon tax, its design and the revenue use, the way each tax was implemented. Whenever we could not find important details in the primary sources, or no primary sources were available (e.g., because the law is too old to be available digitally), we also draw on secondary literature, including scientific and gray literature or media coverage. Some primary sources were not available in English or another language read by one of the authors; these were translated to English with *DeepL.* All quotes in the country sections were translated by the authors or using *DeepL*.

In some Eastern European countries (Poland, Slovenia, Estonia, and Ukraine), we found no primary material justifying the rationale of the tax from the time of implementation, also not through contact with the national ministries, because the laws were implemented before electronic versions of policy documents were archived. For these countries, we found few or no secondary analyses. In these cases, we rely entirely on the policy design analysis and on government statements from later years, which does introduce uncertainty but is unlikely to affect the findings because most of these countries have extraordinarily low carbon taxes (e.g., Poland consistently below US$0.1/t$CO_2$ for over 30 years) without signs of ratcheting up or seeking to raise notable funds. In some cases, we have robust data about the spending only after the first 5 years and can only deduce the initial revenue use from the absence of statements describing use changes. All such uncertainties are discussed in detail in the relevant country sections (Note S2).

RESOURCE AVAILABILITY

Lead contact

Requests for further information and resources should be directed to and will be fulfilled by the lead contact, Johan Lilliestam (johan.lilliestam@fau.de).

Materials availability

All materials generated in this study, notably the 19 national policy analyses, are found in the supplemental information (especially Note S2).

Data and code availability

All data were derived from the mentioned sources and are displayed in entirety in this article or in the supplemental notes, particularly for the country case studies in Note S2. The tax data are, unless stated otherwise, from the World Bank Carbon Pricing Dashboard, available under a CC BY 4.0 license. This paper does not report original code.

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AUTHOR CONTRIBUTIONS

Conceptualization, J.L., J.E., and G.B.; methodology, J.L., J.E., and G.B.; validation, J.L., J.E., and G.B.; investigation, J.L. and J.E.; writing – original draft, J.L.; writing – review & editing, J.E. and G.B.; visualization, J.L.; supervision, J.L.; project administration, J.L.; funding acquisition, J.L.

DECLARATION OF INTERESTS

The authors declare no competing interests.

SUPPLEMENTAL INFORMATION

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