Instrument Effectiveness in the International Climate Discourse

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Abstract

Climate change is one of the most pressing challenges for mankind. The window of opportunity to attain the Paris Agreement goals that aim to limit the global rise of temperatures is closing, despite all national and international efforts. In terms of policy instruments employed by governments to address climate change, in many countries we observe the proliferation of carbon pricing, while fossil fuel subsidies remain an integral part of the policy mix. This paper analyses the effectiveness of carbon pricing instruments and fossil fuel subsidies within the context of the international climate discourse. The paper employs insights from the instrument choice perspective and examines the rationale, the evolution and effectiveness of both carbon pricing and fossil fuel subsidies. In conclusion it offers a critical appraisal and policy suggestions.

Keywords:

Climate change, Carbon pricing, Fossil Fuel Subsidies, Instrument choice

1. Introduction

Mankind has left its mark on the planet, so much so that a new geological epoch has been proposed to reflect the significant human impact on the Earth's geology, landscape, limnology, and ecosystems, including, of course, the climate. While the starting date of the Anthropocene is still under debate, the 1960s have been proposed recently.[1] Anthropological global warming constitutes one of the most pressing challenges for mankind.

Global greenhouse gas (GHG) concentration, measured in parts per million (ppm), has increased ever more quickly from the 1960s, from annual growth rates of less than 1 ppm annually (1960–1970) to close to 2.5 ppm annually during the period 2010–2020.[2] Reflecting the increasing growth rates in GHG emissions, it is unsurprising that we have already reached 430.51 ppm in May 2025.[3]

The most recent Emissions Gap Report of the UNEP shows that we are on a trajectory of a 2.5–2.9°C temperature increase above pre-industrial levels unless countries seriously increase their climate action and deliver more than promised in their 2030 pledges under the Paris Agreement.[4] National ambition levels must increase by at least 28–42 percent compared to the current 2030 policies to get back on track for the 2°C and 1.5°C goals of the Paris Agreement, respectively.[5]

Climate tipping points are already 'possible' at current levels of global warming and may become 'likely' within the Paris Agreement range, indicating that even at low levels of global warming it may not be possible to avoid them.[6] António Guterres, the United Nations Secretary General, eloquently describes our current situation as: "We are on a highway to climate hell with our foot on the accelerator."[7]

Under the Paris Agreement, signatory countries have assumed responsibility to take action against climate change. The level of ambition differs considerably across jurisdictions, often reflecting the principle of "Common but Differentiated Responsibilities". The approaches and instruments taken by the various countries to fight global warming are quite diverse. Instruments can include command-and-control types of instruments (prohibitions or industry standards), but also economic instruments such as taxation or emissions trading systems. Likewise, classical instruments such as subsidies, including fossil fuels, are often part of the toolkit.

Currently, we observe the proliferation of carbon pricing across jurisdictions, while fossil fuel subsidies (FFS) remain an integral part of the policy mix in many countries. This paper analyses the effectiveness of carbon pricing instruments and FFS within the context of the international climate discourse. This research question is approached from an instrument choice perspective.

The paper is structured as follows. Section 2 reviews the rationale and evolution of carbon pricing and examines its effectiveness. Section 3 does the same for FFS. Section 4 critically reflects upon this and draws concluding remarks.

2. Carbon Pricing

What is carbon pricing?

The idea of putting a price on pollution dates back to the work by Arthur Cecil Pigou[8], who argued that externality problems could be corrected by the imposition of a tax. This later became known as the "Pigouvian tax". Accordingly, excessive pollution occurs because the economic actors (the polluters) do not bear the full costs of their action, but are only considering their private costs for decision-making.

1 Meera Subramanian, „Anthropocene Now: Influential Panel Votes to Recognize Earth's New Epoch". *Nature*, May 21, 2019, https://www.nature.com/articles/d41586-019-01641-5.

2 National Oceanic and Atmospheric Administration (NOAA). „Annual Increase of CO_2 at Mauna Loa." https://gml.noaa.gov/ccgg/trends/gr.html.

3 Ibid.

4 United Nations Environment Programme (UNEP), *Emissions Gap Report 2023* (Nairobi: UNEP, 2023), https://www.unep.org/resources/emissions-gap-report-2023.

5 Ibid.

6 OECD. Climate Tipping Points: Insights for Effective Policy Action. (Paris: OECD Publishing, 2022), https://www.oecd-ilibrary.org/docserver/abc5a69e-en.pdf.

7 António Guterres, "Secretary-General's Remarks to High-Level Opening of COP27," speech, Sharm El-Sheikh, Egypt, November 7, 2022, United Nations, https://www.un.org/sg/en/content/sg/speeches/2022-11-07/secretary-generals-remarks-high-level-opening-of-cop27.

8 Arthur Cecil Pigou, *The Economics of Welfare* (London: Macmillan, 1920).

The solution to pollution is therefore to increase the costs to make the private costs of actors reflect all the societal costs. Consequently, pollution will be reduced to socially desirable levels. Taxation can therefore have an important environmental steering effect.

The inherent problem of Pigouvian taxes is that they require the monetary quantification of the marginal environmental damage, which is often unknown. Baumol and Oates (1971) offer a practical solution by requiring the legislator to set a desired standard or target and to estimate the societal costs for this particular quantity. Environmental taxes in the Baumol and Oates tradition would levy the same tax rate for all units of production. Given the administrative ease, most environmental taxes follow the Baumol and Oates tradition.

Emissions trading is a different instrument that also seeks to set a price on pollution. Unlike tax approaches that set a price and leave the environmental effect to be determined by the market, emissions trading systems limit the quantity of pollution that can be emitted and leave the price to be determined by the market. In the Law and Economics literature, emissions trading is often traced back to Demsetz (1967) who argued that externalities should be internalized by allocating property rights.[9] The resource economics literature traces emissions trading back to Dales (1968).[10]

2.1 How did it start in practice?

The international debate on climate change took off at the end of the 1980s. It was sparked by the Brundtland Report (1987), which defined the concept of 'sustainable development', the Toronto Conference on the Changing Atmosphere discussions on international action and the establishment of the 1989 Intergovernmental Panel on Climate Change, which provided a scientific view on climate change and its political and economic impacts. The first carbon pricing instruments, carbon taxes, were introduced in Finland (1990) and Sweden (1991) in the context of the fallout of a major trading partner (the Soviet Union) and severe problems of the Nordic economic model.[11] Norway and Denmark followed suit. In 1992, the European Commission initially sought to introduce a carbon tax as well, but was unable to overcome the unanimity requirement of the EC Treaty. It tried again, but to no avail. At the national level, subsequent waves of carbon taxes occurred in Europe around the 2000s (including Latvia, Estonia, and Croatia) in the context of EU accession, budget consolidation, and emission reduction, and in the 2010s (Ireland, Portugal, and France) in the context of emission reduction, raising revenue and green policy-making.

Emissions trading systems were first used in the context of the US sulfur dioxide (SO2) trading system under the framework of the Acid Rain Program of the 1990 Clean Air Act. At the international level, it was permitted in the context of the 1997 Kyoto Protocol, where Article 17 allows countries that have emission units to spare–emissions permitted to them but not "used"–to sell these to countries that are beyond their targets. Subsequently, other systems at national level were introduced, for example, in the UK or Denmark. At the EU level, emissions trading was introduced with Directive 2003/87/EC in 2003, as it was the only way to prepare the Union for the Kyoto Compliance period (2008–2012). Several emissions trading systems were introduced, inter alia, in California, Québec, in China (national systems and several pilot systems), Tokyo and Saitama, Korea, and others.

9 Harold Demsetz, "Toward a Theory of Property Rights," *American Economic Review* 57, no. 2 (1967):347-359.

10 J.H. Dales, *Pollution, Property and Prices: An Essay in Policy-Making and Economics.* (Toronto: Toronto University Press, 1968).

11 Stefan E. Weishaar, "Introducing Carbon Taxes: Issues and Barriers," in *Innovation Addressing Climate Change Challenges, Market-Based Perspectives*, ed. by Mona Hymel, Larry Kreiser, Janet E. Milne, and Hope Ashiabor, *Critical Issues in Environmental Taxation* (Cheltenham, UK: Edward Elgar Publishing, 2018).

By now, 73 carbon pricing initiatives (either carbon taxation or emissions trading) have been implemented in 39 national jurisdictions.[12] Several more jurisdictions are considering the introduction of carbon pricing initiatives. In 2023, carbon pricing initiatives covered an estimated 11.66 GtCO2e, representing 23% of global GHG emissions.[13] Of these, 2.76 GtCO2e, (or 5.62 percent of global emissions) relate to carbon taxation and the remainder 8.91 GtCO2e (or 17.64 percent of global emissions) to emissions trading systems.[14] While the majority of emissions covered by carbon pricing instruments are covered by emissions trading systems, the overall scope of emissions coverage remains limited. Of course, not only the scope of the pricing instruments should be considered, but also their overall price level. The overall price level in 2023 under the various carbon pricing instruments amounted to US$24.3 per ton of CO2 equivalent.[15] It is interesting to note that the average price per ton of CO2e covered by carbon tax instruments amounted to US$17.6 per tCO2e, while the price under ETS systems was US$26.47 per tCO2e.

Putting the price of emissions subject to carbon pricing in relation to overall global carbon emissions, we attain an overall price of merely US$5.59 per ton of CO2 equivalent for 2023. Even though this constitutes a marked improvement over 2015, where the emissions-weighted carbon price only amounted to around US$1 per ton of CO2[16], it is still nowhere close enough to what is needed. The High-Level Commission on Carbon Prices, convened by the CPLC and co-chaired by Nobel Laureate Joseph Stiglitz and Lord Nicholas Stern, concluded that an explicit carbon price level of US$40–80 per ton of CO2 for 2020 and a price of US$50–100 per ton of CO2 for 2030 would be required to achieve the Paris Agreement targets, provided a supportive policy environment was in place.[17]

What about effectiveness?

The above evidence shows that carbon prices, albeit at the center of international climate discourse, are at this stage at least, not the silver bullet to overcome global warming. Both coverage and prices are generally too low, even if one only considers individual jurisdictions. This does, however, not mean that carbon prices are not effective. Quite on the contrary–there are impressive success stories. Sweden, for example, has increased its carbon prices over time and reached coverage of 95 percent of emissions, and its carbon tax has a price of US$125 per ton of CO2. Moreover, the EU ETS also is applicable in Sweden. Between 1990 and 2022, the country's CO2 emissions fell from 57.51 million tonnes to 38.05 million tonnes, equivalent to a reduction of approximately 34 percent, and this despite GDP growth.[18]

The effectiveness of carbon pricing instruments depends critically on the design choices policy-makers take. Providing a clear vision in terms of environmental target setting, but also locking in clear pricing trajectories and ensuring overall scarcity, is critical in ensuring that carbon pricing indeed translates into an environmental steering effect. Many investments have a long return on investment rate, and policy certainty is key to getting companies to invest in the climate transition of the economy. Tax derogations or free allocation to energy-intensive or trade-exposed (EITE) industries can be counterproductive and undermine transition. An example where the carbon transition has been hindered by effective EITE support schemes is given by the EU ETS.

The European Emissions Trading System was introduced in 2005 and covers

12 World Bank, *Carbon Pricing Dashboard*, accessed January 16, 2024, https://carbonpricingdashboard.worldbank.org/.

13 Ibid.

14 Ibid.

15 Own calculations based on implemented ETS and taxation schemes, data available at: https://carbonpricingdashboard.worldbank.org/map_data, price.

16 G.G. Dolphin, M.G. Pollit, and D.M. Newbery, "The Political Economy of Carbon Pricing: A Panel Analysis," *Oxford Economic Papers* 72, no. 2 (April 2020): 472–500, https://doi.org/10.1093/oep/gpz042, fig. 4.

17 High-Level Commission on Carbon Prices, *Report of the High-Level Commission on Carbon Prices* (Washington, DC: World Bank, 2017), https://www.carbonpricingleadership.org/report-of-the-highlevel-commission-on-carbon-prices.

18 Our World in Data, *Sweden: Annual CO_2 Emissions*, n.d., https://ourworldindata.org/co2/country/sweden#what-are-the-country-s-annual-co2-emissions.

around 45 percent of the EU's GHG emissions from stationary sources, aviation, and maritime shipping. Carbon dioxide, gases, nitrous oxide, and perfluorocarbons fall under the scope of the EU ETS. It is implemented in multiple phases (Phase 1: 2005-2007, Phase 2: 2008-2012, Phase 3: 2013-2020, Phase 4: 2021-2030). The EU ETS is a cap-and-trade system, which means that the environmental effectiveness of the system is safeguarded by the fact that the amount of emission allowances allocated to installations per trading phase is determined by the legislator. Prices have, however, been fluctuating considerably, in part due to government failure (overallocation) and in part due to excess supply (resulting from the economic downturn in 2008/2009). Demand and supply were rebalanced by the creation of the Market Stability Reserve, in which a sizeable number of allowances were taken off the market and cancelled under certain requirements.

Both the energy sector and the industrial sector fall under the same rules, with the main exception that the former has to purchase allowances at auction (since 2013), while the latter is largely subject to free allocation pursuant to the EITE support schemes (around 94 percent of all industrial sectors). While all installations face the same carbon price, the success of emission reduction efforts differs fundamentally. Indeed, most of the reductions in verified emissions stem from the energy sector, while industrial sectors barely reduced any emissions in absolute terms (in relative terms they of course improved their efficiency because there has been economic growth).

In summary, carbon pricing is a highly effective tool in the arsenal for combating global warming. It requires political determination, and smart designs to unleash its full effectiveness. There are several successful examples that legislators can draw upon to design their systems, many of which have gained popularity amongst policymakers these days.

3. Fossil Fuel Subsidies

What are Fossil Fuel Subsidies?

The previous section has examined carbon pricing approaches to address climate change. These approaches seek to put a price on pollution to incentivize lower carbon emissions. A substantial amount of carbon emissions is closely linked to the use of fossil fuels. Fossil fuels include coal, lignite, petroleum, natural gas, oil shales, bitumens, tar sands, and heavy oils. Fossil fuels account for more than 75 percent of global GHG emissions and more than 90 percent of global CO2 emissions.[19] Reducing fossil fuel consumption is thus critical in the quest to reduce global warming. Lamentably, while carbon pricing instruments put a price on pollution, FFS support the use of fossil fuels and hence incentivize pollution.

FFS are policy instruments that directly target fossil fuels or electricity and heat generated from fossil fuels (so-called secondary commodities) through monetary transfers, thereby lowering the costs of fossil fuels and/or energy.[20] By contrast to such direct FFS that entail monetary transfers, indirect FFS are those that do not have a predetermined monetary value or involve actual cash outlays (such as expenditure schemes, discounts, and incomplete pricing).[21]

Despite this seemingly straightforward classification of direct and indirect subsidies, defining what constitutes an FFS is not easy. FFS are highly diverse and can target producers or consumers. In a recent study examining 43 countries, the

19 United Nations, Causes and Effects of Climate Change, n.d., https://www.un.org/en/climatechange/science/causes-effects-climate-change.

20 United Nations Department of Economic and Social Affairs (UNDESA), *UN Handbook on Environmental Taxation* (New York: United Nations, 2023).

21 Ibid.

OECD identified more than 1000 individual fossil fuel policies in use, indicating that countries employ a large number of different schemes simultaneously.[22] When looking for 'inspiration' from international organizations, it becomes apparent that there is significant diversity, both in terms of how fossil fuels are defined, but also in how subsidies are conceptualized.

Fossil fuel definitions used by international organizations differ regarding the inclusion of fossil fuels themselves and of secondary commodities derived from them.[23] Similarly, subsidy definitions used by international organizations (e.g. WTO, OECD, IEA, International Monetary Fund (IMF)) in the context of fossil fuels and the broader energy market differ. These definitions can be based on the form of policy intervention (WTO, UN Environmental Programme (UNEP), and OECD) or on the effect of measures on cost prices (IEA).[24] Only in the context of the WTO Agreement on Subsidies and Countervailing Measures do we find a definition that is legally binding upon all 164 WTO member states, however it is aimed at the analysis of trade distortions. Nevertheless, it is also used by UNEP for monitoring progress for the Sustainable Development Goals 2030 agenda.

The different methodologies are highly significant as they lead to substantially different results and policies. The methodological differences result in widely divergent estimates of the size of FFS between the OECD and the IMF, with the IEA and IMF arriving in 2022 at a figure three times higher than that of the OECD.[25]

The IEA and IMF employ a 'price gap' approach based on energy prices, which involves the comparison of actual end-use fuel prices with reference prices. This method distinguishes between explicit subsidies, where fossil fuel supply costs are undercharged and implicit subsidies, where external or environmental costs are inadequately accounted for or where consumption taxes are forgone.[26]

By contrast to the price gap approach, the OECD follows a bottom-up approach that considers a country's actual policies. Under this approach, direct budgetary transfers and tax expenditures (i.e., tax exemptions or reduced tax rates for certain fuels or activities), that provide benefits or enable conditions for the fossil-fuel sector are considered support measures for fossil fuels. The OECD's methodology critically depends on the baseline rates that tax expenditures relate to, and is consequently better suited to studying policies within a single country than to making cross-country comparisons.

Offering a uniformly applicable definition of FFS that captures all subsidies in all jurisdictions is not feasible, and perhaps not even essential. FFS are highly dependent on the specificities of the energy sector, the economic and social conditions of each country, and the tax regime in which they operate. Thus, there is no 'one-hat-fits-all' solution.

How did it start in practice?

For a long time, fossil fuel subsidies have been discussed at the international level. In 2009, the Group of 20 advanced and emerging market economies (G20) called for the phaseout of inefficient FFS in all countries.[27] This call was reaffirmed in 2012.

The 2015 Paris Agreement itself does not mention FFS. But it sets out the aim to respond to climate change by making 'finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development'.[28] At subsequent COPs in Glasgow (COP26) and Dubai (COP28), the international

22 Organisation for Economic Co-operation and Development (OECD), *OECD Companion to the Inventory of Support Measures for Fossil Fuels 2018* (Paris: OECD Publishing, 2018), https://doi.org/10.1787/9789264286061-en. Data available at: http://www.oecd.org/site/tadffss/data/.

23 For a comparison see United Nations Environment Programme (UNEP), *Measuring Fossil Fuel Subsidies in the Context of the Sustainable Development Goals* (Nairobi: UNEP, 2019), 13, table 5, https://www.unep.org/resources/report/measuring-fossil-fuel-subsidies-context-sustainable-development-goals.

24 For a comparison see UNEP (2019) *Measuring Fossil Fuel Subsidies in the Context of the Sustainable Development Goals*, 15 https://www.unep.org/resources/report/measuring-fossil-fuel-subsidies-context-sustainable-development-goals.

25 OECD, "Cost of Support Measures for Fossil Fuels Almost Doubled in 2022 in Response to Soaring Energy Prices," *OECD Newsroom*, December 1, 2023, https://www.oecd.org/en/about/news/press-releases/2023/12/cost-of-support-measures-for-fossil-fuels-almost-doubled-in-2022-in-response-to-soaring-energy-prices.html.

26 Simon Black, Antung A. Liu, Ian W. H. Parry, and Nate Vernon, *IMF Fossil Fuel Subsidies Data: 2023 Update* (Washington, DC: International Monetary Fund, August 24, 2023), https://www.imf.org/en/Publications/WP/Issues/2023/08/22/IMF-Fossil-Fuel-Subsidies-Data-2023-Update-537281.

27 International Monetary Fund (IMF), "Energy Subsidies," n.d., https://www.imf.org/en/Topics/climate-change/energy-subsidies.

28 United Nations Framework Convention on Climate Change (UNFCCC). The Paris Agreement, Nov 2015, available at https://unfccc.int/documents/37107, see Article 2.1.c.

community called for the phasing out of inefficient FFS, while emphasizing the need for targeted support for those most affected by energy poverty. Specifically, at the COP26, the Glasgow Climate Pact was concluded, which calls upon parties to accelerate efforts toward the "phase-out of inefficient FFS, while providing targeted support to the poorest and most vulnerable in line with national circumstances and recognizing the need for support towards a just transition."[29] Importantly, at the COP28 in 2023, parties were called upon to take actions including "transitioning away from fossil fuels in energy systems, in a just, orderly and equitable manner, accelerating action in this critical decade, so as to achieve net zero by 2050 in keeping with the science" and to "phasing out inefficient FFS that do not address energy poverty or just transitions, as soon as possible".[30]

What about effectiveness?

Despite the many challenges in defining, measuring, and identifying FFS at the international and national levels, and despite the methodological caveats that must be raised when trying to compare them across jurisdictions, it should be stressed that FFS can influence the effectiveness and goals of carbon taxes and other pricing instruments. They can be described as "countervailing policies" to carbon taxes, as they have contradictory objectives or adverse effects on decarbonization.

Moreover, it should be noted that, independent of any carbon pricing instruments employed, FFS serve to incentivize and lock in fossil fuel consumption and, hence, greenhouse gas emissions. The phaseout of FFS should therefore be considered in its own right.

Why do countries, on the one side, put a price on carbon, while on the other side, they subsidize its use? The reason is, of course, that FFS may serve other important goals, such as supporting low-income groups, disadvantaged regions, or economic sectors, and others, but they lead to increased carbon emissions and potentially negative effects on a country's budgetary position. A trade-off between the long-term effect on climate change and the short-term expediency of retaining political acceptance of policy measures and budgetary considerations may tip the balance toward keeping FFS. It should be noted, however, that avoiding GHG emissions is less costly than sequestering emissions, adapting to global warming, or incurring damages in the future.

From an economic perspective, there are several insights concerning the application of subsidies and various other types of support schemes. Lump-sum transfers, or energy vouchers, stamps, or in-kind transfers enable recipients to spend an amount on the supported commodity. This allows recipients to consume more of the supported good. However, the administrative costs and associated social stigmas may differ. Importantly, such "earmarked" transfers limit the recipients' freedom to decide how to spend their disposable income themselves in a way that maximizes their benefits and, hence, overall efficiency.

An alternative to supporting consumption is to support production or influence market prices via subsidies or regulation,[31] so that the subsidized product becomes cheaper and consumers can consume more. All consumers, rich and poor, will be better off because they can consume more of the subsidized product. Yet, their benefits will be lower, as only cash transfers allow consumers the freedom to choose how to spend their money so as to purchase the combination of goods that maximizes their welfare.

29 United Nations Framework Convention on Climate Change (UNFCCC), "Recital 36, Decision 1/CMA.3, Glasgow Climate Pact," *Conference of the Parties Serving as the Meeting of the Parties to the Paris Agreement*, Third Session, Glasgow, October 31–November 13, 2021, https://unfccc.int/sites/default/files/resource/cma2021_10_add1_adv.pdf.

30 United Nations Framework Convention on Climate Change (UNFCCC), "Recital 28(d) and (h), Draft Decision -/CMA.5," *Conference of the Parties Serving as the Meeting of the Parties to the Paris Agreement*, Fifth Session, Dubai, November 30–December 12, 2023, UNFCCC, https://unfccc.int/sites/default/files/resource/cma2023_L17_adv.pdf. The Global Stocktake recognizes the science that indicates that global greenhouse gas emissions need to be cut by 43 percent by 2030, compared to 2019 levels, to limit global warming to 1.5°C. But it notes that parties are off track in meeting their Paris Agreement goals. See https://unfccc.int/news/cop28-agreement-signals-beginning-of-the-end-of-the-fossil-fuel-era

31 One example of such regulation is the German feed-in tariff, which the government set for feeding renewable energy into the grid at a predetermined price that had to be paid by energy utilities to renewable energy generators (often households with solar panels on their roofs).

It must be pointed out that subsidies are generally viewed critically by economists, because they distort the market and are often less targeted toward low-income households. This renders them very costly. To address the regressivity associated with decarbonization, energy transition, and energy security, targeted cash grants are preferable to general FFS. Moreover, as is the case with voucher, stamp, or in-kind transfers, subsidies can also give rise to "public choice"-type of problems. All support schemes should, therefore, be closely examined to determine whether they are indeed necessary and useful. Related to the general critique of FFS and their efficiency considerations, subsidies are thus not cost-effective.

The impact of FFS is enormous. According to the broad definition used by the IMF, global FFS reached US$7 trillion in 2022, or nearly 7.1 percent of global GDP.[32] Eighteen percent of these subsidies are categorized as explicit subsidies, where fossil fuel supply costs are undercharged. A staggering 82 percent are categorized as implicit subsidies, where environmental costs are undercharged or where consumption tax revenues are forgone. While explicit subsidies are projected to remain limited, implicit subsidies are projected to increase slightly until 2030, both in absolute value and in terms of percentage share of GDP.[33] Reducing FFS thus makes economic sense.[34] Some countries—for example Vietnam—nearly phased out all FFS in 2015.[35] Fossil fuels are highly relevant from an economic perspective, but what about them and their effectiveness in relation to climate change? FFS are a countervailing measure that generally works to the detriment of climate policy.

More telling than the monetary values of FFS or their GDP shares is, however, their impact on global warming and the extent to which they affect the prospects of reaching the Paris Agreement targets. Raising fuel prices to their fully efficient levels would reduce projected global fossil fuel CO2 emissions by 34 percent below 2019 levels by 2030, which would be enough to keep countries on track for containing global warming within the Paris Agreement goal of 1.5-2°C.[36] This is no mean feat, considering that the growth rates of GHG emission concentrations in the atmosphere are still increasing and that the window of opportunity for avoiding irreversible damage due to climate change is closing.

Phasing out FFS is therefore absolutely critical to addressing climate change. Not supporting fossil fuel consumption will directly impact the reduction of CO2 emissions. Even though reducing FFS is critical, it is not as easy as it would appear. There are many vested interests involved whenever subsidies have to be phased out. Importantly, the regressive effect of higher fuel or energy prices can be politically very sensitive, as was demonstrated by the Yellow Vests Protests, which commenced in France in 2018 as a movement motivated by rising crude oil and fuel prices, a high cost of living, and economic inequality.

Adverse economic shocks, such as the Covid-19 pandemic or the war in Europe, have shown that, despite the best intentions of many governments in addressing climate change, FFS have increased significantly. Between 2020 and 2022, explicit subsidies have more than doubled to US$1.3 trillion. This reflects the recent price hike in global energy markets, and it is expected that explicit subsidies will decline as international prices recede.[37] This example clearly shows that many countries, especially in EU member states, have failed to keep FFS in check. Even worse, many of these subsidies were not targeted at those most in need but were instead rather broad economic measures.

To summarize, fossil fuels are responsible for a tremendous share of global warming, but phasing out subsidies has not gained substantial traction at the

32 Simon Black et al., "IMF Fossil Fuel Subsidies Data," 2023.

33 International Monetary Fund (IMF), "Energy Subsidies," n.d.

34 That said, there are of course policy considerations that may require the use of FFS, for example, to support low-income populations.

35 Although FFS were reintroduced in 2020 (during the Covid-19 pandemic), see https://fossilfuelsubsidytracker.org/country/.

36 International Monetary Fund (IMF), "Energy Subsidies," n.d.

37 Simon Black et al., "IMF Fossil Fuel Subsidies Data," 2023.

international level. Phasing out FFS is complicated by vested interests, national energy mixes, and resulting economic and social constraints. Often FFS are not sufficiently targeted at the poor but instead accrue to large segments of society, rendering them less effective and harmful to the environment.

It should, however, also be pointed out that defining FFS is also inherently difficult since they may include both subsidies given through direct government spending but also given through tax advantages which are depending on the respective general tax measure that is deviated from. Tax measures may be highly specific and more favorable for fossil fuels based on additional criteria, for example, those related to specific fiscal federal structures, strategic sectors or social enterprises and cooperatives. Normally, a tax expenditures report published during the budgetary process would be necessary to identify and quantify specific deviations from general national tax rules, providing at least an indication of what might constitute an FFS.

4. Concluding reflections

The previous sections have shown that both carbon pricing and reducing FFS are critical pillars in the fight against global warming. While carbon pricing has been pursued for several decades in various jurisdictions, curbing FFS appears to be a more recent development in international climate discourse. Both are effective in their own way. If pursued vigorously, they could be highly effective in stemming the tide, finally breaking the acceleration of GHG emissions, and even leading to an actual reduction in emissions. Both approaches lead to higher energy prices and, hence, require public support—especially the support of relevant stakeholders and low-income households who need protection from the regressive effects of these policy instruments. More often than not, the wish list of stakeholders is long when they are asked to make sacrifices for the environment.

Moreover, both approaches essentially depend on market forces to bring about decarbonization of the economy. This requires sending clear and predictable price signals to economic actors. If the experience of the EU ETS or the Australian Carbon Pricing Mechanism serves as a benchmark, its significance should not to be underestimated. The former suffered from prolonged low prices, and the latter was phased out after a few years. Moreover, clever design and clear policy objectives are key in order to realize the climate goals. Here the EU ETS can again serve as an example. Since it did not have a price support measure, prices were low for several years.

The lynchpin of both approaches is, however, that time is running out. Setting economic incentives for actors to respond and do the right thing is both efficient and effective, and hence highly desirable. Yet it requires time for transition, as well as the right market environment. The environmental steering effect of carbon pricing and the phasing out of FFS will be particularly effective if viable alternatives are available.

In a similar manner, the transition of the economy toward a large-scale implementation of carbon-efficient technology will best be achieved if infrastructural preconditions are satisfied. Bottlenecks to transition need to be addressed, and governments may very well be required to take a proactive role in identifying and resolving them. This is particularly important, as there will not be a single blueprint that is uniformly applicable across all jurisdictions. On the contrary, jurisdictions differ in their natural endowments. Some countries possess mountains that lend

themselves for the construction of pumped-storage systems, others have abundant sunshine, wind, or harbors that allow for the importation of oil. Naturally, their energy mixes will vary, as will their potential for transitioning and the infrastructural conditions required. A comprehensive, tailor-made plan and strong government foresight are therefore necessary to provide the right market framework and infrastructure as the economy transitions.

Since the window of opportunity to address climate change is closing, countries aim to substantially reduce carbon emissions, several of them to net zero by 2050 or earlier. In order to generate enough clean energy, substantial investments in new technology are required. Since new technology takes significant time to develop to the point that it is actually scalable, it is essential that investments flow especially toward proven green technologies that are already scalable. This can be achieved via several policy instruments, including pricing instruments (such as FFS phaseouts, ETS or carbon taxation). In addition, the use of regulation and standards should not be underestimated.

Standards and regulations are the epitome of "command-and-control" types of instruments. They are generally considered to be inflexible, as public law stipulations must be adhered to. They require substantial subject knowledge on part of the legislator, which is often lacking, exposing them *inter alia* to regulatory capture. Moreover, command-and-control instruments are time-consuming and costly to legislate, must be monitored and enforced, and are generally difficult and time-consuming to update. They are thus generally considered to be less efficient, but effective in a static environment where the government has sufficient knowledge to regulate them. Considering the context of climate change, where new and more stringent targets are set every few years in quick succession, perhaps relying on command-and-control regulation may not be appealing at first. However, given the need to implement proven technology quickly in order to advance the transition toward a carbon-neutral economy, the importance of these policy instruments should be reconsidered. They deserve to be part of a smart instrument mix.

The above has shown that the international climate discourse has centered largely around carbon pricing as a tool to address global warming. The phaseout of FFS is becoming more important but is not yet an integral part of the discourse. Regrettably, the debate about command-and-control instruments has also not yet taken off.

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