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Carbon pricing and deep decarbonisation

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ABSTRACT

Experts frequently point to carbon pricing as the most cost-effective tool for reducing greenhouse gas emissions. Empirical studies show that carbon pricing can successfully incentivise incremental emissions reductions. But meeting temperature targets within defined timelines as agreed under the Paris Agreement requires more than incremental improvements: it requires achieving net zero emissions within a few decades. To date, there is little evidence that carbon pricing has produced deep emission reductions, even at high prices. While much steeper carbon prices may deliver greater abatement, political economy constraints render their feasibility doubtful. An approach with multiple instruments, including technology mandates and targeted support for innovation, is indispensable to avoid path dependencies and lock-in of long-lived, high-carbon assets. We argue that carbon pricing serves several important purposes in such an instrument mix, but also that the global commitment to deep decarbonisation requires acknowledging the vital role of instruments other than carbon pricing.

1. Introduction

Carbon pricing is recommended by experts as the most cost-effective tool for reducing greenhouse gas (GHG) emissions (e.g. Stiglitz et al., 2017, see also Mehling and Tvinnereim, 2018). This is almost certainly true for reductions at the margin, but averting dangerous climate change requires more than incremental abatement of emissions. Modelling efforts have pointed to the importance of reaching net zero emissions as soon as possible during this century to avoid the most dangerous effects of global warming (van Vuuren et al., 2011). Parties to the Paris Agreement have therefore committed to deep decarbonisation: collectively, these countries have agreed to the objective of keeping global warming well below 2 °C above pre-industrial levels, and of achieving net zero emissions during the second half of the century.

Deep decarbonisation requires wholesale transformation of the economy, and we argue that instruments geared toward cost reductions at the margin cannot be expected to achieve such structural change on their own. Nonetheless, carbon pricing is currently being advanced in multiple venues as the single most important policy instrument to address climate change, dominating political debates and benefitting from substantial public resources for stakeholder outreach, public diplomacy and capacity building. A recent article, for instance, argues that "among all instruments carbon pricing deserves the most serious attention from researchers, politicians, and citizens" (Baranzini et al., 2017). Our concern is that such an exclusive focus on carbon pricing could hold back the study and deployment of other necessary mitigation policies, and may ironically contribute to stranded assets and higher costs to both emitters and society at large.

In this Policy Perspective, we start by reviewing the empirical track record of how carbon pricing has contributed to reduce emissions (Section 2). We then point out its limitations, notably incurred by the geophysical limits of the atmosphere combined with political economy constraints on price levels and coverage (Section 3). Based on these observations, we argue that carbon pricing has shown potential to halt the increase in emissions (inflow), but that we cannot rely on it to stabilize absolute concentration levels (stock). We go on to discuss policy interactions, including what can go wrong when carbon prices are implemented sub-optimally (Section 4). Finally, we conclude on the proper place of carbon pricing in a wider global warming mitigation portfolio, arguing that prices work best on existing capital stock while technology mandates and innovation policies should dominate the field of new investment.

2. Incremental mitigation: a positive track record

As a concept, carbon pricing can have different meanings: it can denote a climate change mitigation tool, an input in energy-economy-climate models, and a theoretical construct to represent the social cost of global warming. Here, we focus on the first dimension, its role as an instrument of climate policy, which has been defined by the World Bank as "initiatives that put an explicit price on greenhouse gas

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emissions, i.e., a price expressed as a value per ton of carbon dioxide equivalent (tCO_2e)" (World Bank, 2017a, p. 20). In practical terms, an explicit price on greenhouse gas emissions can be implemented by a fixed payment obligation in the form of a carbon tax, charge, or levy, or alternatively through a limit on aggregate emissions where a market for tradable emission permits – often referred to as a cap-and-trade system – reveals the price.

Economic theory commonly casts climate change as one or several market failures that each need to be addressed using a dedicated policy instrument (Goulder and Parry, 2008). One such market failure – the unpriced externality of climate damages – can be addressed with the introduction of the foregoing carbon pricing policies.

Evidence from existing carbon taxes, for instance, confirms their ability to lower emissions relative to a business-as-usual scenario. Sterner (2007) has noted that global emissions from transport would have been much higher if Europe and Japan had not had high fuel tax levels, which are functionally similar to a carbon tax. Bruvoll and Larsen (2004) argue that the relatively high Norwegian carbon tax implemented in 1991 contributed to reducing emissions per unit of GDP over the period 1990–1999. Andersson (2017) analyses the case of the Swedish carbon tax, also implemented in 1991, comparing actual transport sector emissions to business-as-usual emissions. The counterfactual emission trajectory derives from a "synthetic Sweden" based on data from OECD countries that did not introduce significant carbon taxes. These modelling exercises suggest that emissions are 11% lower in an average year due to the combination of a carbon tax and a value added tax on transport fuel, compared to the counterfactual. Andersson argues that the persistence and credibility of carbon taxes influences vehicle purchase decisions, thus producing a greater long-term effect on emissions than oil price fluctuations. Lin and Li (2011) find some emission reductions from carbon taxes in five North European countries, but note that exemptions reduce the effectiveness of these taxes. Computable general equilibrium modelling and econometric difference-in-difference studies of the carbon tax introduced in British Columbia in 2008 suggest that it resulted in a 5–15% decline in fossil fuel use by 2012 (Murray and Rivers, 2015).

Likewise, carbon pricing through cap-and-trade systems has proven to be effective in mitigating emissions (Schmalensee and Stavins, 2017). Mandated emission trajectories result in absolute emission reductions over time. Under the European Union emissions trading system (EU ETS), a cap-and-trade system that has been in place since 2005 and currently covers 31 countries, available evidence suggests that emissions across all regulated sectors declined by around 3% during the first five years of operation, relative to estimated business-as-usual emissions (Martin et al., 2016: 143). A cap-and-trade system for the electricity sector introduced by a group of states in the U.S. Northeast and Mid-Atlantic in 2009, the Regional Greenhouse Gas Initiative (RGGI), has also contributed to emissions abatement, although a majority of emission reductions stem from investments in energy efficiency and renewable energy financed through auctioning revenue (Hibbard et al., 2018). Overall, emission reductions under cap-and-trade systems have tended to occur at lower prices than initially expected, demonstrating the potential cost-effectiveness of pricing mechanisms (Tvinnereim, 2014).

3. Deep decarbonisation: a mixed track record

3.1. Relative, absolute and deep emission reductions

Based on the empirical works reviewed so far, carbon prices have clearly demonstrated a potential to reduce emissions relative to business-as-usual trajectories. At the same time, several studies acknowledge that total emissions under carbon taxes have grown, not declined, in the relevant countries and sectors over the studied periods. Cap-and-trade systems have seen absolute emission reductions, but changes have been marginal rather than deep.

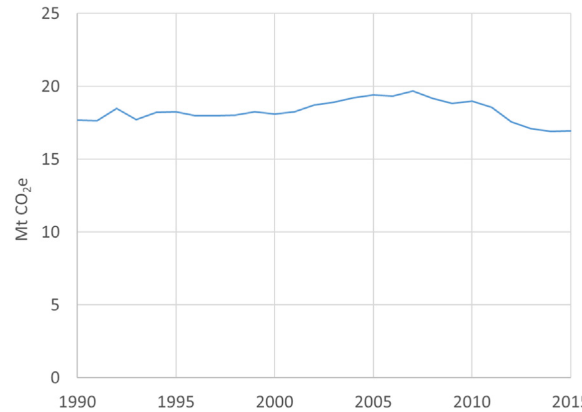

Fig. 1. Swedish emissions, UNFCCC category 1.A.3.b Road Transportation, 1990–2015.
Source: UNFCCC.

The Swedish example, which has already been mentioned, is useful. Sweden has one of the highest carbon prices in the world – arguably the highest – at US$140 per tonne of CO_2 (World Bank, 2017b). This makes it an important case study for carbon pricing: if anything, the Swedish experience should underscore the mitigation potential of a price on carbon. And yet, emissions in covered sectors have only decreased incrementally and not consistent with a deep decarbonisation pathway. Specifically, Sweden's road transportation emissions declined only four percent from 1990 – the year before the carbon tax was introduced – to 2015, see Fig. 1.

But how high is the Swedish carbon price compared to the projected abatement cost of averting serious climate change, as indicated by climate models? In its latest assessment report, the Intergovernmental Panel on Climate Change (IPCC) presented an overview of idealised energy-economy-climate models consistent with the strictest concentration target of 430–480 ppm CO_2e by 2100 (IPCC, 2014: Fig. 6.21(a), p. 450). Among the 34 scenarios presented, the lower-quartile carbon price was US$37 and the upper-quartile price US$67 per tonne of CO_2 in 2020. The corresponding range for 2050 was US $127-US$305 per tonne. These prices are based on marginal abatement costs under given emission trajectories, and are thus not directly comparable with actual carbon taxes; the scenarios also typically do not assume early mitigation from transportation (IPCC, 2014, p. 480). Nevertheless, a carbon pricing policy at or exceeding the projected abatement cost should spur sufficient mitigation to remain on a reduction pathway broadly consistent with the foregoing climate target. As this comparison illustrates, carbon prices within modelled, high-ambition mitigation cost ranges already exist, but their abatement effect in the real world may diverge from the abatement levels projected by modelling efforts.

3.2. Geophysical limits

As seen above, carbon prices can spur incremental emission reductions or cause emissions to decline relative to counterfactual levels. So far, however, the empirical track record does not document deep emission reductions resulting from carbon pricing on its own.

Why does this matter? Incremental abatement or emission reductions relative to a counterfactual baseline are a good start, but are not good enough when the goal is to eliminate virtually all emissions in the short to medium term. Deep decarbonisation within a rigid timeline is an urgent imperative, according to the literature on "carbon budgets", which posits that humanity only has a finite amount of greenhouse gases left to emit in order to achieve the 2 °C target (Meinshausen et al., 2009). Because of the long-lived nature of greenhouse gases in the atmosphere, stabilisation of their concentrations in the atmosphere (the