

Lurking in the shadows: The impact of CO₂
emissions target setting on carbon pricing and
environmental efficiency.

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Abstract

This paper studies the impact of CO₂ emissions target setting. We empirically investigate the targets set during the Kyoto Protocol period using a convex non-parametric least squares system, quantile regressions, and a comprehensive data set of 125 countries. Our findings reveal CO₂ marginal abatement costs, which: (1) are significantly higher for target setting countries; (2) increase over the sample period; (3) and are an order of magnitude greater than the prevailing emissions pricing mechanisms. The results provide insights into the consequences of policies to curb unwanted by-products in a regulated system and shed light on the price efficiency of carbon markets. Furthermore, we contribute to the debate on emission reduction standard-setting and highlight the importance of shadow price estimates when regulating market instabilities in an emission trading scheme.

Introduction

The World Health Organization predicts significant health risks associated with climate change. Their analysis estimates around 250,000 additional deaths per year from 2030 to 2050, assuming the status quo of current abatement practices and global economic growth¹. The reduction of greenhouse emissions and the impact on climate change are existential challenges of the 21st century. Many countries have adopted emissions reductions targets since the dawn of the Kyoto Protocol (hereafter KP)² in response to this challenge. The nature and efficacy in response to this challenge of these targets have attracted considerable conceptual debate (for example, see Angelis, Di Giacomo, and Vannoni (2019)), but few empirical studies on the impact of explicit target setting.

We attempt to solve this puzzle by testing the differences between target-setting and non-target-setting countries. We use an identification strategy that more accurately estimates the impact of target setting on carbon pricing and environmental efficiency. Specifically, we focus on the KP target setting period and analyse CO₂ emissions for 125 countries. Considering only CO₂ emissions allow for a representative sample of non-target setting Countries (non-annexed 1 Countries) and more meaningful group comparisons in our statistical tests. We use quantile system of convex nonparametric least squares regressions (CQR) to estimate shadow prices (see equation (1) in Kuosmanen and Zhou (2021a)) and an improved marginal abatement cost (MAC) of CO₂ emissions (Xian et al. 2022; Dai, Zhou, and Kuosmanen 2020; Kuosmanen, Zhou, and Dai 2020; Kuosmanen and Zhou 2021b). Convex nonparametric least squares has recently been found to admit a causal interpretation between inefficiency and productivity (Tsionas 2022). Moreover, our method allows for an examination of the factors which help explain relative (in)efficiencies.

We find that target setters during the first KP commitment period were more environmentally inefficient than non-target setters, an unintended consequence of the regulation. We also note that countries with a higher degree of industrialisation and those with more urban populations exhibit lower environmental efficiency. Our results also assert that the marginal cost of CO₂ reduction during the first KP period was an order of magnitude higher than the trading price of CO₂ in the EU-ETS. This result suggests considerable price inefficiency in the emissions market.

Our findings have important implications for international carbon regulation. Authors have highlighted potential gains in CO₂ mitigation from emission trading schemes (for example, Kumar, Managi, and Jain 2020). Our findings add

¹These statistics are taken from the WHO factsheet on climate change and health <https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health>

²The KP was principled on the idea of hard targets for emissions reduction for industrialised nations and the EU. These were developed in tandem with carbon trading mechanisms, the largest of which is the EU Emissions Trading System (EU-ETS). These developments brought not just matters of environmental production efficiency to the fore but also those relating to carbon price discovery.

to this debate. We show that the shadow prices and market prices of CO₂ diverge in the KP period, suggestive of a consistent misallocation of the traded allowances in the EU emissions trading scheme (ETS). Our results also show an imbalance in shadow pricing due to target setting. These significant frictions in the price discovery of an ETS market may result in a surplus of allowances, exacerbating market instability, and a lower carbon price. The latter likely weakened the incentives to lower emissions. We argue that when policymakers debate structural measures to promote market stability, such as predefined rules to place unallocated allowances in a market stability reserve, shadow price imbalances due to target setting must be considered[3].

In the next section, we review the literature on the impact of the KP on emissions and productive efficiency. Next, we describe the frontier models and data used. We follow with a discussion of our findings and conclusions.

Literature Review

The academic inquiry into the effective management of climate change has a rich history. Historically, holistic models seek to understand how human development, societal choices, and the natural world integrate and influence each other. At a simplistic level, they can estimate the social cost of carbon pollutants. This top-down approach to the economics of climate change has been at the forefront of the discipline

. However, such a global approach may prove dated in the face of stalled international coordination on climate change policy.

Against the bedrock of climate science, the KP agreement was an ambitious attempt to coordinate across borders on targets for emissions reduction. The KP set out to differentiate reduction targets equitably in terms of a nation’s industrial development, a comparable level of pollution, and the ability to mitigate the ecological damage of global emissions levels. Specifically, countries were categorised into two Annexes. Annex 2 countries, which set explicit targets, were mostly developed nations, with higher industrial production. Annex 1 countries, defined as developing, were not subject to targets, although most ratified the Protocol.

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