

HOW MUCH CLIMATE POLICY HAS COST YOUR COUNTRY?

Timo Kuosmanen, Aalto University School of Business, Helsinki, Finland, +358 947001, timo.kuosmanen@aalto.fi
Xun Zhou, Aalto University School of Business, Helsinki, Finland, +358 947001, xun.zhou@aalto.fi
Sheng Dai, Aalto University School of Business, Helsinki, Finland, +358 947001, sheng.dai@aalto.fi

Overview

Global climate change, attributed to the increased levels of green-house gases (GHG) produced by the use of fossil fuels, is widely considered as the most difficult challenge for sustainable development. Increasing concentration of GHG in the atmosphere contributes to global warming, which has already lead to increasing frequency and intensity of extreme weather events around the world. In the future, global warming and more severe weather events are expected to inflict severe loss of life and damage to property as well as eco-systems. Poor countries and regions are expected to suffer disproportionately larger damage costs.

International treaties to mitigate climate change date back to the early 1990s. The United Nations Framework Convention on Climate Change (UNFCCC) was opened for signature in Rio de Janeiro in 1992, and has been subsequently ratified by all member states of the United Nations. Five years later in 1997, a group of 52 industrialized countries signed a treaty known as the Kyoto Protocol where the signatory countries committed themselves to binding GHG emission reduction targets. The first commitment period was completed in 2008-2012, and the second commitment period takes place in 2013-2020. Parties to the UNFCCC continue to meet on a regular basis to discuss climate policy beyond 2020.

In the late 1990s, the economic cost of Kyoto Protocol was intensively debated both in academic and political arenas. A seminal study by Nordhaus and Boyer (1999) applies Computable General Equilibrium (CGE) model to estimate the global cost of the Kyoto Protocol. According to their model, the net present value of total cost is \$716 billion US dollars, of which the share of the USA would be almost two thirds. They also argue that the Kyoto Protocol is highly cost-ineffective with the total cost 7 times higher than the benefit. Murkowski (2000) calculates that the average cost for a US household would be as high as \$2,728 per year, leading to eradication of 2.4 Million jobs. The perceived high cost on the US economy has been the most important single reason for the USA to decline from ratification of the Kyoto Protocol.

As the second commitment period of the Kyoto Protocol draws to its end in 2020, it is high time to shed empirical light on the cost of Kyoto, and climate policy in general. However, any empirical cost assessment of climate policy involves many severe challenges. Firstly, specifying an appropriate counterfactual to Kyoto is far from self-evident. As noted above, several countries that signed the Kyoto Protocol have later withdrawn from their commitments, or simply failed to comply with their targets. On the other hand, countries that did not commit to the Kyoto targets have also implemented voluntarily abatement measures. Secondly, leakage of emissions through trade to developing countries with lower emissions standards is a well-recognized problem. Thirdly, there are indirect costs and benefits that are difficult to measure. For example, measures to abate CO₂ may also lead to reduction in PM and SO_x emissions, improving the air quality at local or regional levels.

Methods

The purpose of this study is to address the first challenge by estimating the total abatement cost of the actual change of GHG emissions relative to 1990, the benchmark year of the Kyoto Protocol. More specifically, we approximate the total cost by multiplying the observed reduction in GHG emissions by its marginal abatement cost. To estimate the marginal abatement cost, we resort to convex quantile regression (Kuosmanen et al., 2015; and Kuosmanen and Zhou, 2018), which is a data-driven estimation method that combines the key advantages of convex nonparametric regression and quantile regression.

The main appeal of convex regression is that it draws its power from standard axioms of economic theory such as monotonicity and convexity, and does not depend on any arbitrary functional form assumptions. The key advantage of using quantiles is that impacts of inefficiency, stochastic noise, and heteroscedasticity in empirical data are explicitly modeled without any restrictive prior assumptions (Kuosmanen and Zhou, 2018). Further, our

estimation of marginal abatement cost takes into account a broader set of abatement options than most previous studies.

Results

Table 1 reports the main results of this paper: the average yearly abatement cost per capita for the sample of OECD countries during the period 1990-2015. Countries are classified in four groups, and sorted within each group according to the abatement cost per capita from largest to smallest. Positive values reflect the magnitude of economic burden due to reduction of GHG emissions, whereas negative values can be interpreted as the economic benefit derived from increase in GHG emissions relative to the 1990 level, the benchmark year in the Kyoto Protocol.

Table 1: Abatement cost per capita per year (€ / person, prices of 2010), average of 1990-2015

EU-15		EU transition economies	
Luxembourg	112	Czech Republic	30
United Kingdom	83	Slovak Republic	15
Denmark	67	Hungary	15
Sweden	57	Poland	12
Germany	48	Slovenia	11
Finland	48	Estonia	3
Belgium	42	Latvia	3
Netherlands	23		
France	22	Non-European OECD	
Italy	14	United States	-9
Austria	2	Israel	-30
Greece	-2	New Zealand	-48
Ireland	-8	Canada	-61
		South Korea	-75
		Australia	-76
EFTA			
Norway	-6		
Iceland	-36		

According to our results, however, the GHG abatement is not nearly as expensive as the most pessimistic forecasts in the late 1990s projected. This is due to the fact that most estimates completely ignore inefficiency in production as well as input-side abatement alternatives.

Conclusions

Unbiased estimation of abatement cost is critically important for policy making. We believe that the perceived prohibitively high price of GHG abatement was the main reason why the USA never ratified the Kyoto Protocol. If the scientific community can convincingly demonstrate that the actual economic cost has been much lower than the exaggerated forecasts portrayed in the most pessimistic studies, then it would be much easier for policy makers to commit to more ambitious GHG emission reductions that are considered necessary by the IPPC. We hope that this study can be a first step in this direction, motivating further research on this critically important topic.

References

Kuosmanen, T., A.L. Johnson, and A. Saastamoinen (2015) Stochastic nonparametric approach to efficiency analysis: A unified framework, in: J. Zhu (Ed.) *Data Envelopment Analysis*. Springer, Boston, MA, pp. 191-244.

Kuosmanen, T., and X. Zhou (2018) Shadow Prices and Marginal Abatement Costs: Convex Quantile Regression Approach, working paper. Available online at: <https://www.researchgate.net/publication/329268893>.

Murkowski, F.H. (2000) The Kyoto Protocol is not the Answer to Climate Change, *Havard Journal on Legislation* 37(1), 345-367.

Nordhaus, W.D., and J.G. Boyer (1999) Requiem for Kyoto: An Economic Analysis of the Kyoto Protocol, *The Energy Journal* 20, 93-130.