Environmental Policy and Directed Technological Change: Evidence from the European carbon market

Raphael Calel*[1] and Antoine Dechezleprêtre[1,2]

[1]Grantham Research Institute on Climate Change and the Environment, London School of Economics
[2]Centre for Economic Performance, London School of Economics

Overview

The European Union Emissions Trading Scheme (EU ETS) was launched in 2005 and is today the world's largest carbon market. Under the scheme, around 11,000 power stations and industrial plants in 30 countries are allocated tradable emissions permits, covering 40% of the EU's total greenhouse gas emissions. When regulated firms expect to face a higher price on emissions relative to other costs of production, this provides them with an incentive to make operational changes and investments that reduce the emissions intensity of their output, and indeed, the EU ETS was primarily intended to reduce carbon emissions through innovation (rather than output reduction). This vision has been articulated many times by EU policy makers, who envisage the EU ETS to be a driving force of the transition to a low-carbon economy. We leverage a unique data set—recording firm characteristics, patenting activities, and regulatory status for over 6 million European companies—to investigate the impact of the EU ETS on low-carbon technological change in the first 5 year of the Scheme's existence.

Methods

In the first instance, we perform exploratory data analysis to try to understand what, if any, impact the EU ETS has had on aggregate low-carbon patenting in Europe. To address concerns relating to the questionable comparability of regulated and unregulated companies, we then estimate the difference-in-differences (before/after and regulated/unregulated) using a matched sample of over 700 firms operating EU ETS installations and nearly 1'000 that do not. The firms are matched for pre-2005 characteristics. Several possible competing explanations for our findings are discussed and subjected to systematic scrutiny—omitted variable bias, peer effects, innovation among third-party technology suppliers, etc.

Results

Exploratory data analysis suggests that the EU ETS might account for as much as 25–30% of the low-carbon patents filed by EU ETS regulated companies between 2005 and 2009. However, we also find

*E-mail for correspondence: r.calel@lse.ac.uk. Contact address: Grantham Research Institute on Climate Change and the Environment, London School of Economics, Houghton Street, London WC2A 2AE, UK.

indications that this is an overestimate resulting from systematic pre-EU ETS differences between the unregulated and would-be regulated companies. Matching on pre-2005 characteristics results in a balanced sample, and more reliable estimates. The difference-in-differences estimate for this matched sample shows that EU ETS firms have not responded with more low-carbon innovation. We test a number causal and technical interpretation of this finding, and conclude the most likely interpretation is that the EU ETS has had no impact on low-carbon patenting.

Conclusions

The EU ETS forms an integral part of the European Union's roadmap to a low-carbon economy in 2050. Moreover, policy makers in the process of implementing new carbon market programs in New Zealand, the North-Eastern United States, Australia, and elsewhere, can learn from the EU ETS experience. New low-carbon technologies are needed, but our findings suggest that the EU ETS in its current form might not be enough to incentivize low-carbon technological change. Even before the EU ETS launched, many argued it would not impact firm innovation behaviour because of an overly generous allocation of emissions permits, and that permits were awarded to polluters free of charge (Schleich and Betz, 2005; Gagelmann and Frondel, 2005; Grubb et al., 2005). It has also been suggested that policies like the EU ETS may fail to bring about low-carbon technological change unless combined with complementary technology-push policies (Jaffe et al., 2005; Fischer and Newell, 2008; Acemoglu et al., 2012). Our findings are consistent with the conclusion that a price on carbon emissions alone—whether in principle or in practice—has not been sufficient to encourage low-carbon technological change.

References

Acemoglu, D., Aghion, P., Bursztyn, L., and Hemous, D. (2012). The Environment and Directed Technical Change. *The American Economic Review*, 102(1):131–166.

Fischer, C. and Newell, R. G. (2008). Environmental and technology policies for climate mitigation. *Journal of Environmental Economics and Management*, 55(2):142–162.

Gagelmann, F. and Frondel, M. (2005). The impact of emission trading on innovation-science fiction or reality? *European Environment*, 15(4):203–211.

Grubb, M., Azar, C., and Persson, U. (2005). Allowance allocation in the European emissions trading system: a commentary. *Climate Policy*, 5(1):127–136.

Jaffe, A., Newell, R., and Stavins, R. (2005). A tale of two market failures: Technology and environmental policy. *Ecological Economics*, 54(2-3):164–174.

Schleich, J. and Betz, R. (2005). Incentives for energy efficiency and innovation in the european emission trading system. *ECEEE Summer Studies Proceedings*.