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Leaving Coal Unburned: Options for Demand-Side and Supply-Side Policies

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Climate policy consistent with the 2°C target needs to install mechanisms that leave most current coal reserves unburned. Demand-side policies have been argued to be prone to adverse carbon leakage and “green paradox” effects. A growing strain of literature argues in favor of supply-side policies in order to curb future coal consumption. Various concepts with analogies in other sectors are currently discussed. Future empirical research on both demand- and supply-side policy is vital to be able to design efficient and effective policy instruments for climate change mitigation.

Curbing future coal consumption is essential for climate change mitigation, given that coal has the highest carbon-intensity of any fossil fuel and is responsible for the largest share of CO₂ emissions from fuel combustion (46 per cent in 2013) (IEA 2015c, 9–10). The role of coal is reinforced by recent work to quantify a carbon budget that is consistent with the internationally-agreed climate target of avoiding more than a 2°C temperature increase. Meinshausen et al. (2009) found that, in order to remain within a carbon budget consistent with the 2°C target, more than half of all oil, gas and coal reserves must remain unburned during the period to 2050. McGlade and Ekins (2015) extended this work by assessing the welfare-maximizing distribution of fossil fuels that must remain unburned, finding that 82 per cent of global coal reserves must remain unburned during the period to 2050, compared to 33 per cent of oil reserves and 49 per cent of gas reserves. These estimates already include widespread deployment of technologies such as carbon capture, transport, and storage (CCTS) and high efficiency boilers, which are thought to play a role in sustaining coal use while reducing its climate impacts.

Recently coal use has been declining in OECD countries, but a ‘renaissance of coal’ has been observed in non-OECD countries (Steckel, Edenhofer, and Jakob 2015). It is evident that more effective policies are needed to curb global coal consumption to a level that is consistent with achieving the 2°C target. Such policies should target steam coal and lignite (the set of coal types typically combusted to produce electricity and heat, which represents around 85 per cent of global coal consumption (IEA 2015b, III.21,III.32,III.34)) above metallurgical coal, which does not have readily available substitutes.

Demand-side policies

Demand-side policies for reducing emissions, which provide indirect incentives to reduce coal consumption, have received the most attention in the academic

literature and have been most commonly introduced in practice. Carbon pricing instruments place an explicit price on emissions – either directly, as a carbon tax, or indirectly, through a cap-and-trade scheme (OECD 2013a). Such instruments have been implemented (or are scheduled to be implemented) in 39 countries, and at the jurisdictional level in a further 3 countries (Kossoy et al. 2015, 22). There are many other policy instruments which generate an implicit carbon price, such as taxing energy use, imposing emissions standards, or mandating the use of low-emissions energy sources. Other demand-side policies include measures that promote energy efficiency and reduced energy consumption. All these types of policy instruments are used across many countries, and may serve other goals in addition to reducing emissions (OECD 2013a). The Grantham Research Institute maintains a database of global climate legislation which details different policies that have been implemented (Grantham Research Institute 2015).

Under the right conditions, market-based carbon pricing instruments are theoretically the most efficient policy instruments for reducing emissions (e.g. Stavins 2003). Practical outcomes appear to support the theory, with cap-and-trade schemes and carbon taxes found to drive more abatement at lower cost compared to some other policy instruments (OECD 2013b). However the effectiveness of these instruments may be undermined by inadequate design and implementation. For instance, prior to the commencement of the European Emissions Trading Scheme (EU ETS) it was predicted that its effectiveness would be reduced due to suboptimal permit allocations (Kemfert, Diekmann, and Ziesing 2004), and this has now eventuated in practice (Ellerman, Valero, and Zaklan 2015; Neuhoff et al. 2015). Consequently, the EU ETS and similar economic instruments in place worldwide have only generated low carbon prices (averaging €5 per tonne of CO₂ in 2014 (IEA 2015a, 23)). In contrast, higher carbon prices are needed to drive substitution away from coal in the power generation sector – for instance, one recent estimate of the price that would drive coal-to-gas switching in Europe is around €40 (Gray 2015, 49). Moreover, it is likely that even higher carbon prices are necessary to drive the closure of old, fully-depreciated, coal-fired generators (IEA 2014, 16).

Carbon leakage and the green paradox

In the absence of full participation in a global climate policy, demand-side policies are susceptible to carbon leakage: emissions-intensive activities shift to non-participating countries, such that emissions reductions in the participating countries are partly offset by emissions increases in the non-participating countries (see e.g. Felder and Rutherford 1993; Sinn 2008). Richter (2015) provides an overview of empirical studies of the carbon leakage effect, which is undisputed in existence, but controversial in magnitude. Ex-ante, the supply elasticity of coal is found to be crucial for the magnitude of the effect, with higher elasticity leading to stronger leakage effects (Burniaux and Oliveira Martins 2012). Using General Equilibrium frameworks that incorporate the interaction between trade and the environment, most studies find only moderate rates of leakage (Felder and Rutherford 1993; Paltsev 2001; Di Maria and van der Werf 2008). High rates of carbon leakage are estimated by Babiker (2005), who criticizes overly simplistic assumptions on market and industry structure. Employing an integrated assessment framework, Arroyo-Currás et al. (2015) identify a limited leakage of 15 per cent, if the U.S., the EU and China act as pioneer regions. In an ex-post empirical study of the effect of the Kyoto Protocol on GHG emissions, Aichele and Felbermayr (2015) find a change in the production patterns of emission-intensive goods and thereby evidence for carbon leakage of about 8 per cent. Combined with earlier findings by Aichele and Felbermayr (2012), the carbon leakage rate is estimated at roughly 40 per cent.

A “green paradox” has also been theorized, where the expectation of future demand-side policies could induce resource producers to increase their present rates of extraction in order to maximize net present value (Sinn 2015). While Haftendorn, Kemfert, and Holz (2012) suggest that in practice the green paradox may not be relevant to the steam coal market, Bauer et al. (2013) find a short term reduction of coal prices due to stringent climate policy.

Supply-side policies

Against the background of little progress on the demand-side there is a growing strain of literature on policies which address the supply of coal. One type of supply-side policy acts to directly remove coal reserves from production – whether to a partial extent (focusing on high-extraction-cost reserves for economic efficiency) (Harstad 2012), or to a further extreme, the progressive closure of the entire coal industry (Collier and Venables 2014). Another type of supply-side policy is a depletion tax (or alternatively, a depletion quota), which is analogous to the demand-side policy of a carbon tax (or for a depletion quota, a carbon budget). For instance, Richter et al. (2015) proposed a tax on the energy content of steam coal, levied by a coalition of major coal exporters. Their modelling shows that a tax levied by a coalition of major coal exporters is preferable to a tax levied by a single major coal exporter, and that a production tax generates better outcomes than an export tax (though they note a production tax is likely to be politically contentious). A supply-side policy for coal could also take the form of an export-licensing regime adopted by a coalition of major coal exporters, in analogy to the existing safeguards regime for uranium exports; based on the reasoning that the regulation of commodity exports on the basis of their harmful or unethical end use is a widely accepted principle, and should be extended to coal (A. Martin 2014). Lazarus, Erickson, and Tempest (2015) provide a comprehensive taxonomy of supply-side climate policies.

Collier and Venables (2014) make the case that, in the absence of full participation in a global climate policy, a targeted supply-side policy will be more effective in reducing emissions from coal combustion than a demand-side policy. In particular, carbon leakage is minimized under a supply-side policy rather than a demand-side policy if the price elasticity of demand is high relative to the price elasticity of supply – which is considered to be the case for coal in the long-run (Collier and Venables 2014). The threat of a green paradox is also thought to be eliminated with a properly designed supply-side policy – in particular, one that targets high-cost coal deposits for closure (Hoel 2013). Other benefits of supply-side policies are that they achieve predictable and observable outcomes with low transaction costs (Collier and Venables 2014). It has also been suggested that supply-side climate policies may drive greater emissions reductions for a given marginal cost, and will limit over-supply of fossil fuels and associated “carbon lock-in” effects (Lazarus, Erickson, and Tempest 2015).

An important consideration in relation to supply-side policies is whether producers should be compensated for the loss in profits associated with the coal that is not produced. A number of studies suggest that under a policy of freely allocated depletion quotas, enhanced scarcity rents for fossil fuels that are extracted can offset the loss in profits (Eisenack, Edenhofer, and Kalkuhl 2012; Kalkuhl and Brecha 2013; Asheim 2013); and similarly for a policy which confiscates fossil fuel reserves (Asheim 2013). These findings indicate that there is no need for overall compensation under those policies. However there may still be a need for compensation payments between producers to alleviate internal distributional effects, whereby producers with low-extraction-cost reserves will benefit at the expense of other producers (Asheim 2013).

To date, there has been limited experience with the implementation of supply-side policies. The concept of preserving fossil fuel reserves has some precedent in the Yasuni-ITT Initiative, which was a proposal by the Ecuadorian government in 2007 to preserve oil reserves, but ultimately was not carried through (P. L. Martin 2014). A recent initiative that directly targets future coal supply is the “No New Coal Mines” campaign. It is supported by the Australia Institute and argues in favor of a global moratorium on new coal mines that should be debated at the 2015 Paris Climate Conference (Denniss 2015).

Conclusion

It is clear that reducing emissions from coal consumption is necessary for meeting the 2°C target. This may be achieved through policies that act to reduce the demand for coal, or emerging policies that act to limit the supply of coal. The optimal choice of policies for different countries will need to be tailored to national circumstances, and will also depend on feasibility of implementation. In theory, supply-side policies appear to be an effective alternative or complement to demand-side policies, particularly in the absence of full participation in a global climate policy. To back up the theoretical arguments on both demand- and supply-side climate policies, future empirical research is vital to be able to design efficient and effective policy instruments for climate change mitigation.

References

- Aichele, Rahel, and Gabriel Felbermayr. 2012. “Kyoto and the Carbon Footprint of Nations.” *Journal of Environmental Economics and Management* 63 (3): 336–54. <http://dx.doi.org/10.1016/j.jeem.2011.10.005>.
- . 2015. “Kyoto and Carbon Leakage: An Empirical Analysis of the Carbon Content of Bilateral Trade.” *Review of Economics and Statistics* 97 (1): 104–15. http://dx.doi.org/10.1162/REST_a_00438.
- Arroyo-Currás, Tabaré, Nico Bauer, Elmar Kriegler, Valeria Jana Schwanitz, Gunnar Luderer, Tino Aboumahboub, Anastasis Giannousakis, and Jérôme Hilaire. 2015. “Carbon Leakage in a Fragmented Climate Regime: The Dynamic Response of Global Energy Markets.” *Technological Forecasting and Social Change* 90, Part A (January): 192–203. <http://dx.doi.org/10.1016/j.techfore.2013.10.002>.
- Asheim, Geir B. 2013. “A Distributional Argument for Supply-Side Climate Policies.” *Environmental and Resource Economics* 56 (2): 239–54. <http://dx.doi.org/10.1007/s10640-012-9590-2>.
- Babiker, Mustafa H. 2005. “Climate Change Policy, Market Structure, and Carbon Leakage.” *Journal of International Economics* 65 (2): 421–45. <http://dx.doi.org/10.1016/j.jinteco.2004.01.003>.
- Bauer, Nico, Ioanna Mouratiadou, Gunnar Luderer, Lavinia Baumstark, Robert J. Brecha, Ottmar Edenhofer, and Elmar Kriegler. 2013. “Global Fossil Energy Markets and Climate Change Mitigation – an Analysis with REMIND.” *Climatic Change*, October, 1–14. <http://dx.doi.org/10.1007/s10584-013-0901-6>.
- Burniaux, Jean-Marc, and Joaquim Oliveira Martins. 2012. “Carbon Leakages: A General Equilibrium View.” *Economic Theory* 49 (2): 473–95. <http://dx.doi.org/10.1007/s00199-010-0598-y>.
- Collier, Paul, and Anthony J. Venables. 2014. “Closing Coal: Economic and Moral Incentives.” *Oxford Review of Economic Policy* 30 (3): 492–512. <http://dx.doi.org/10.1093/oxrep/gru024>.
- Denniss, R. 2015. “When you’re in a hole - stop digging!” The Australia Institute. <http://www.tai.org.au/content/when-you-are-hole-stop-digging>.
- Di Maria, Corrado, and Edwin van der Werf. 2008. “Carbon Leakage Revisited: Unilateral Climate Policy with Directed Technical Change.” *Environmental and Resource Economics* 39 (2): 55–74. <http://dx.doi.org/10.1007/s10640-007-9091-x>.
- Eisenack, Klaus, Ottmar Edenhofer, and Matthias Kalkuhl. 2012. “Resource Rents: The Effects of Energy Taxes and Quantity Instruments for Climate Protection.” *Energy Policy*, Special Section: *Frontiers of Sustainability*, 48 (September): 159–66. <http://dx.doi.org/10.1016/j.enpol.2012.05.001>.
- Ellerman, Denny, Vanessa Valero, and Aleksandar Zaklan. 2015. “An Analysis of Allowance Banking in the EU ETS.” Working Paper. RSCAS Working Papers. Florence, Italy: Florence School of Regulation. <http://cadmus.eui.eu/handle/1814/35517>.
- Felder, Stefan, and Thomas F. Rutherford. 1993. “Unilateral CO₂ Reductions and Carbon Leakage: The Consequences of International Trade in Oil and Basic Materials.” *Journal of Environmental Economics and Management* 25 (2): 162–76. <http://dx.doi.org/10.1006/jeem.1993.1040>.
- Grantham Research Institute. 2015. “The Global Climate Legislation Database | Grantham Research Institute on Climate Change and the Environment.” The Global Climate Legislation Database. <http://www.lse.ac.uk/GranthamInstitute/legislation/the-global-climate-legislation-database/>.

- Gray, Matthew. 2015. "Coal: Caught in the EU Utility Death Spiral." Carbon Tracker. <http://www.carbontracker.org/wp-content/uploads/2015/06/CTI-EU-Utilities-Report-v6-080615.pdf>.
- Haftendorn, Clemens, Claudia Kemfert, and Franziska Holz. 2012. "What about Coal? Interactions between Climate Policies and the Global Steam Coal Market until 2030." *Energy Policy* 48: 274–83. <http://dx.doi.org/10.1016/j.enpol.2012.05.032>.
- Harstad, Bård. 2012. "Buy Coal! A Case for Supply-Side Environmental Policy." *Journal of Political Economy* 120 (1): 77–115. <http://dx.doi.org/10.1086/665405>.
- Hoel, Michael. 2013. "Supply Side Climate Policy and the Green Paradox." http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2214897.
- IEA. 2014. "Energy, Climate Change and Environment: 2014 Insights." Energy, Climate Change and Environment. Paris, France: International Energy Agency, Organisation for Economic Co-operation and Development. http://www.oecd-ilibrary.org/energy/energy-climate-change-and-environment_9789264220744-en
- . 2015a. "World Energy Outlook Special Report 2015: Energy and Climate Change." *World Energy Outlook*. <http://www.worldenergyoutlook.org/energyclimate/#d.en.143801>.
- . 2015b. Coal Information 2015. Coal Information. IEA. http://www.oecd-ilibrary.org/energy/coal-information-2015_coal-2015-en.
- . 2015c. CO₂ Emissions from Fuel Combustion Highlights 2015. CO₂ Emissions from Fuel Combustion. Paris, France: International Energy Agency, OECD Publishing. <http://www.iea.org/publications/freepublications/publication/CO2EmissionsFromFuelCombustionHighlights2015.pdf>.
- Kalkuhl, Matthias, and Robert J. Brecha. 2013. "The Carbon Rent Economics of Climate Policy." *Energy Economics* 39 (September): 89–99. <http://dx.doi.org/10.1016/j.eneco.2013.04.008>.
- Kemfert, Claudia, Jochen Diekmann, and Hans-Joachim Ziesing. 2004. "Emissions Trading in Europe: Effective Tool or Flight of Fancy?" *Intereconomics* 39 (3): 119–21. <http://link.springer.com/article/10.1007%2FBF02933575>.
- Kosoy, Alexandre, Grzegorz Peszko, Klaus Oppermann, Nicolai Prytz, Noemie Klein, Kornelis Blok, Long Khanh Lam, Lindee Wong, and Bram Borkent. 2015. "State and Trends of Carbon Pricing 2015." 99533. The World Bank. <http://documents.worldbank.org/curated/en/2015/09/25053834/state-trends-carbon-pricing-2015>.
- Lazarus, M, P Erickson, and K Tempest. 2015. "Supply-Side Climate Policy: The Road Less Taken." SEI Working Paper 2015-13. http://sei-us.org/Publications_PDF/SEI-WP-2015-13-Supply-side-climate-policy.pdf.
- Martin, Aran. 2014. "Commodity Exports and Transboundary Atmospheric Impacts: Regulating Coal in an Era of Climate Change." *Environmental Politics* 23 (4): 590–609. <http://dx.doi.org/10.1080/09644016.2014.891788>.
- Martin, Pamela L. 2014. "Ecuador's Yasuní-ITT Initiative: Why Did It Fail?." *International Development Policy | Revue Internationale de Politique de Développement* 6: 2014. <http://poldev.revues.org/1705>.
- McGlade, Christophe, and Paul Ekins. 2015. "The Geographical Distribution of Fossil Fuels Unused When Limiting Global Warming to 2 °C." *Nature* 517 (7533): 187–90. <http://dx.doi.org/10.1038/nature14016>.
- Meinshausen, Malte, Nicolai Meinshausen, William Hare, Sarah C. B. Raper, Katja Frieler, Reto Knutti, David J. Frame, and Myles R. Allen. 2009. "Greenhouse-Gas Emission Targets for Limiting Global Warming to 2[thinsp][deg]C." *Nature* 458 (7242): 1158–62. <http://dx.doi.org/10.1038/nature08017>.
- Neuhoff, K., W. Acworth, R. Betz, D. Burtraw, J. Cludius, H. Fell, C. Hepburn, et al. 2015. "Is a Market Stability Reserve Likely to Improve the Functioning of the EU ETS?: Evidence from a Model Comparison Exercise." VIII. Climate Strategies. London, UK. http://www.diw.de/sixcms/detail.php?id=diw_01.c.497154.de.
- OECD. 2013a. "Climate and Carbon: Aligning Prices and Policies." OECD Environment Policy Paper. Paris, France. http://www.oecd-ilibrary.org/environment-and-sustainable-development/climate-and-carbon_5k3z11hjg6r7-en.
- . 2013b. "Effective Carbon Prices." OECD Publishing. http://www.oecd-ilibrary.org/environment/effective-carbon-prices_9789264196964-en.
- Paltsev, Sergey V. 2001. "The Kyoto Protocol: Regional and Sectoral Contributions to the Carbon Leakage." *Energy Journal* 22 (4): 53–79. <http://web.mit.edu/paltsev/www/pubs/ej2001.pdf>.
- Richter, Philipp M. 2015. "Trade and Climate Policies: The Role of Market Structure, Strategic Behaviour, and the Supply Side of Carbon." Berlin, Germany: Technische Universität Berlin. https://opus4.kobv.de/opus4-tuberlin/files/6914/richter_philipp.pdf.
- Richter, Philipp M., Roman Mendelevitch, and Frank Jotzo. 2015. "Market Power Rents and Climate Change Mitigation: A Rationale for Coal Taxes?" DIW Berlin, Discussion Paper 1471 ID 2598402. Berlin, Germany: German Institute for Economic Research (DIW Berlin). http://www.diw.de/sixcms/detail.php?id=diw_01.c.502680.de.
- Sinn, Hans-Werner. 2008. Public policies against global warming: a supply side approach. *International Tax and Public Finance*, 15(4). 360–94. <http://dx.doi.org/10.1007/s10797-008-9082-z>.
- . 2015. "Introductory Comment—The Green Paradox: A Supply-Side View of the Climate Problem." *Review of Environmental Economics and Policy* 9 (2): 239–45. <http://dx.doi.org/10.1093/reenp/rev011>.
- Stavins, Robert N. 2003. "Chapter 9 - Experience with Market-Based Environmental Policy Instruments." In *Handbook of Environmental Economics*, edited by Karl-Göran Mäler and Jeffrey R. Vincent, 1:355–435. Environmental Degradation and Institutional Responses. Elsevier. <http://www.sciencedirect.com/science/article/pii/S1574009903010143>.

Steckel, Jan Christoph, Ottmar Edenhofer, and Michael Jakob. 2015. "Drivers for the Renaissance of Coal." *Proceedings of the National Academy of Sciences* 112 (29): E3775–81. <http://dx.doi.org/doi:10.1073/pnas.1422722112>.

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