EFFECTS OF CARBON MITIGATION ON CO-POLLUTANTS AT INDUSTRIAL FACILITIES IN EUROPE

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Section 1:

In addition to global climate benefits, carbon mitigation improves local air quality by reducing emissions of hazardous co-pollutants. Using data on large industrial point sources in Europe, we estimate how changes in carbon dioxide emissions affect emissions of the three co-pollutants SO_X, NO_X, and PM_{10} for samples of 630 to 2,400 facilities for the years 2007 to 2015. We find substantial and statistically significant co-pollutant elasticities of about 1.0 for SO_X, 0.9 for NO_X, and 0.7 for PM_{10}. These elasticities vary by economic activity, and are substantially higher for the production of energy. For climate policy-induced CO_2 emission reductions we find elasticities in the energy sector of 1.2 to 1.8 for SO_X, 1.1 to 1.5 for NO_X, and 0.8 for PM_{10}. Using these estimates to calculate monetary air quality co-benefits suggests that conventional European Environmental Agency estimates of carbon damages that omit co-benefits significantly underestimate the benefits of carbon mitigation.

Section 2:

Carbon combustion simultaneously releases carbon dioxide (CO_2) and air pollutants such as sulfur oxides (SO_X), nitrogen oxides (NO_X), and particulate matter (PM). More stringent climate policies therefore may generate air quality and public health co-benefits. Omitting these co-benefits may lead to substantial underestimation of the economic benefits from carbon mitigation. To estimate the full social cost of carbon, or what Shindell (2015) terms the "social cost of atmospheric release," air quality co-benefits need to be incorporated along with climate benefits.

A crucial difference between CO_2 and co-emitted air pollutants – also termed co-pollutants – is that CO_2 is a uniformly mixed pollutant: a ton of emissions has the same climate impact independent of the location of release, and hence abatement is most efficient wherever its marginal costs are lowest, again independent of the location. Co-emitted air pollutants, by contrast, are non-uniformly mixed: the environmental and health damages are proximate to the location of release, and hence the total health damages depend on the number of people exposed (see, e.g., Muller and Mendelsohn 2007). For pollutants of the latter type, spatially differentiated policies have been recommended that take into account variations in damages, and hence abatement benefits, as well as in abatement costs (Boyce and Pastor 2013).

Despite the importance of air quality co-benefits from economic, public health, and environmental perspectives, there has been little empirical research on the relationship between CO_2 emissions and co-pollutants at the level of individual pollution sources. Most previous analyses are either simulation studies relying on ad hoc parameters to calculate the impact of carbon mitigation on co-pollutant emissions and their regional distribution, or are based on aggregate data that can return misleading results if the two types of pollutants are partially an outcome of different economic activities (i.e. caused by different sources).

Section 3:

This paper's investigation of co-pollutant elasticities with respect to CO_2 emissions is based on facility-level data, disaggregated across sources and across co-pollutants. It provides useful inputs not only for assessing the overall magnitude of air quality co-benefits from carbon mitigation policies, but also for the design of differentiated policies that take into account variations in co-pollutant damages per ton of CO_2. For industrial point sources in Europe as a whole, we find that in the time period 2007 to 2015 a 1% reduction in CO_2 emissions resulted in about a 1.0% reduction in emissions of SO_X, 0.9% of NO_X, and a 0.7% of PM_{10}. In the electricity sector, which is the largest contributor to Europe's industrial carbon emissions, these elasticities were higher: a 1% reduction in CO_2 emissions is associated with a 1.6% reduction in SO_X and a 1.0% reduction in NO_X and PM_{10} emissions. Elasticities in the electricity sector for CO_2 reductions specifically induced by climate policies are at 1.2% to 1.8%, 1.1% to 1.5%, and 0.8% for SO_X, NO_X, and PM_{10}, respectively. These findings imply that assuming a co-pollutant elasticity of one may lead to an underestimation of overall co-benefits.

Monetizing the health impacts of policy induced co-pollutant emissions using EEA estimates of damage costs, we obtain air quality co-benefits of 46 to 132 Euros per ton of CO_2 for the three co-pollutants jointly. This is substantially higher than EEA estimates of climate damage costs per ton of CO_2. Since co-pollutant emissions cause excess economic and health damages in the EU that are not sufficiently addressed by existing co-pollutant regulations, the implication of this finding is that higher carbon prices can be justified in Europe as a “no regrets” policy, independent of their climate benefits. Due to sectoral differences in co-pollutant intensities and elasticities, our results suggest that differentiated carbon mitigation policies may improve efficiency beyond that of uniform policies. Even if there is only one carbon price, however, the presence of positive spillovers from CO_2 regulation on underregulated co-pollutant emissions warrant a higher carbon price than one that only includes CO_2 damages.

Section 4:

Potentially fruitful areas for future research include comparison of co-pollutant intensities and elasticities for industrial point sources to those for other emission sources, notably transportation. Facility-level studies in other countries and regions would shed light on whether and how European elasticities compare to corresponding sectors elsewhere. Finally, the fine degree of geographical resolution that can be obtained from facility-level data can be applied to the analysis of spatial differentiation in air quality co-benefits, an important policy issue from the standpoint of equity as well as efficiency.

References

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