Air Pollution Damages from Offshore Energy Production

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In the United States (U.S.) offshore extraction accounted for nearly 30 percent of total domestically produced oil and 12 percent of domestically produced natural gas in 2011. The consequences of such large scale operations on coastal and marine environments is the subject of considerable public scrutiny and regulatory attention. Indeed, most environmental regulatory attention, as well as that of the popular media, focuses on water pollution-related impacts of extraction. Less well known is the fact that offshore platforms comprise a significant source of certain air pollutants; in 2008, total emissions of nitrogen oxides (NO_x) exceeded 60,000 tons while total releases of volatile organic compounds (VOC) approached 50,000 tons.

This analysis measures the impact of emissions of air pollution generated from offshore drilling operations incurred in the contiguous U.S. in pursuit of the following questions. First; what is the total damage caused by airborne emissions from active platforms in the Gulf of Mexico? Second; what is the spatial distribution of damages among active platforms? And third; conditional on the answers to the first two questions; what is an appropriate regulatory prescription to manage airborne emissions in the Gulf?

The paper measures total damages from emissions of four criteria air pollutants including: sulfur dioxide (SO_2), NO_x, VOCs, and fine particulate matter ($PM_{2.5}$). The impacts of emissions of two greenhouse gas (GHG) emissions – carbon dioxide (CO_2) and methane (CH_4) - are also valued. Damages are measured for 2000, 2005, and 2008. To do this, spatially-detailed marginal damage estimates for the criteria pollutants (estimated using an integrated assessment model in this paper) and peer-reviewed marginal damage estimates for the GHGs are matched to detailed emission inventories at the platform level.

In pursuit of the second question above, which focuses on the spatial distribution of damages, the paper computes impacts from each of the extant offshore platforms in the Gulf of Mexico. By coupling the air pollution and GHG damage produced by operations at each platform with reported extraction at each platform, the paper is able to estimate the marginal social cost of extraction (expressed in $/barrel terms) at each operating platform in the three data-years covered by the analysis.

This leads to the third question which is related to optimal policy design; the marginal social cost estimates are used to evaluate whether a one-size-fits-all approach to managing air pollution emissions from offshore platforms is appropriate or whether a more nuanced regulatory approach is called for. For example, the current approach to managing emissions from offshore platforms consists of a mix of command-and-control approaches (ambient, technology, and fuel content standards, for example). As is well-known in the environmental economics literature, this approach is only optimal if firms face the same abatement cost schedules *and* if their emissions cause the same degree of harm. If either costs or damages vary, efficiency requires a regulatory approach that is more flexible at the firm or facility level. So the current paper essentially tests whether damages, at the margin, vary by platform with the objective of informing regulatory design for offshore rigs.

An integrated assessment model, AP2, is used to link offshore emissions to impacts on air quality and human health in each county in the U.S. AP2 is used to compute marginal damages for the fleet of existing oil and gas rigs to estimate the total air pollution damages and damages by platform for all of the existing offshore extraction platforms. The integrated assessment modeling chain begins with an offshore emission of a particular pollutant, say, SO_2. AP2 then predicts the change in ambient concentrations in each county in the contiguous U.S. associated with that emission. County-level inventories of people, crops, and man-made materials facilitate computing exposures to each pollutant of these potentially sensitive populations. Peer-reviewed dose-response functions are then employed to translate such exposures into physical effects. These include premature deaths, increased rates of illness, reductions in crop yields, and enhanced depreciation of man-made materials. Finally, AP2 contains a valuation module that attributes a dollar value to each effect. For crops and man-made materials AP2 uses evidence of the value of these physical losses from market transactions: crop prices and the replacement cost of man-made materials.

In order to estimate the air pollution and climate impacts due to extraction from active platforms in the Gulf of Mexico, this paper employs Gross External Damage (GED) which is computed as the marginal damage times emissions. Emissions and production data are matched for the years 2000, 2005, and 2008 in order to calculate damages per barrel of oil equivalent (BOE) production. In 2000, an average platform in the western Gulf produced GED* of $426,000. This is estimated to have increased to $1.7 million in 2005 and $1.4 million in 2008. In the central Gulf of Mexico, an average platform in 2000 generated GED* estimated at $1.2 million. In 2005, the GED* produced by an average platform was tabulated at $2.8 million which increased slightly in 2008 to $2.9 million. The analysis finds that production yields damages of between $0.31 and $0.75/BOE in the western Gulf and between $0.26 and $0.57/BOE for platforms in the central Gulf. Although the weighted-average damages per unit extraction are relatively small (the $/BOE values reported above are less than 1 percent of nominal market prices for oil) a small number of sources produce large social costs per BOE extracted. For example, in 2008, a source at the 95th percentile is estimated to generate damages valued at $27/BOE in the western Gulf and $13/BOE in the central Gulf region. The analysis goes on to argue that, from a policy perspective, the sources that yield large marginal social costs are important to regulate for two reasons. First, the marginal social costs are very high relative to most other platforms. As a result, reallocating production from these high-damage platforms to lower-damage facilities makes sense on efficiency grounds. Second, the total BOE produced from these high-damage facilities is quite small. Therefore, a binding regulatory constraint on production at such facilities is not likely to have an appreciable impact on either wholesale or retail fuel prices.