Title: The Cost of Industrial Air Pollution

**Aim:** The aim of this project is to assess the effectiveness in the different industrial approaches to calculating the costs of industrial air pollutants. This is an extension of a previous *Asthma Files* project on the economic burdens of asthma in the United States which used similar methods and models to draw conclusions including the total expenditure as a percentage of United States GDP. The initial stage of research will examine a variety of methods for measuring the economic costs of air pollution. These methods can be divided into two core frameworks: (1) The impact pathway approach and (2) emissions market value. These frameworks have been applied to multiple air pollution studies.

Next, a look into the practice of these methods using case studies. These case studies will highlight three different approaches: (1) the impact pathway approach, (2) emissions trading, and (3) carbon offsetting. The case studies chosen have a macroeconomic focus to gain a broader understanding of the successes and failures of each. A more focused, microeconomic analysis will be done in further stages of this research to be applied to The Asthma Files 6 Cities Project.

The final stage of research will look at the 6 cities highlighted in The Asthma Files project: Albany, Bangalore, Beijing, Houston, New York City, and Philadelphia. There will be a deeper analysis of how/ if these cities use methods for calculating the costs of air pollution, how those methods are applied to air pollutant reductions, and if these programs have been successful. The final expenditures for each city will be reported in US dollars. This research will establish a framework for assessing how each of the 6 cities calculate air pollution costs and if their policies based on these costs are effective.

**Introduction:** Over the last 50 years air pollution has been a growing concern throughout the world. From the United States Clean Air Act of 1970 to the EPA’s recently passed Clean Power Plan (Aug. 2015), air pollution has become a part of the political agenda. Even though air pollution and air quality are growing in importance, significant sustainable plans have yet to be put into place. Organizations ranging from the EPA to NGOs such as The Sierra Club, all aim to force political action and improve air quality.

A significant economic loss due to air pollution has potential to drive for such plans. By focusing on methods for evaluating the costs of air pollutants I hope to identify effective ways for measuring the cost of air pollutants and establishing a framework to enforce those methods.

The Cost of Air Pollution: Methods

**Impact Pathway Approach:** Created in the 1990s between the European Commission and the US Department of Energy (USDA), the impact pathway approach “quantifies the damage costs imposed on society and the environment due to energy use” (European Environment Agency, p.18). This approach takes three core steps: (1) identify pollutant emissions, (2) determine impacts of emissions, and (3) quantify damage costs in monetary terms.

First, identifying pollutant emissions has the most variety in method. Depending on which industry is being assessed the pollutants will be different. Some of the most studied pollutants were: carbon dioxide, nitrogen oxides, sulfur oxides, ammonia, and particulate matter. Looking even further, most studies have separate methods for assessing carbon dioxide which will be covered in a further section of this report. Carbon Dioxide is well known as the primary greenhouse gas pollutant which has led to another method all together for addressing CO2 emissions (EPA, p. ES-1). The primary industries studied for emissions data included the energy sector, manufacturing combustion, production processes, transportation, and agriculture which consistently had a lower damage cost from emissions compared to other sectors.

Next, determine the impacts of emissions using value of life year (VOLY), value of statistical life (VSL), or productivity loss due to morbidity.

VOLY is “an estimate of damage costs based on the loss of life expectancy” (European Environment Agency, p.23). Simply put, in the case of this study when someone dies from air pollutant emissions, their value is calculated by their life expectancy subtracted by the age at which they died multiplied by their current or expected wage. This creates a value of life, a controversial measure that does not account for differences in wages or other environmental, economic and health factors. For example, the New York Times reported a 2010 value of life (not life year) to equal $9.1 million from the EPA, $7.9 million from the FDA, and $6 million from the transport department (New York Times). The variation in these values alone demonstrate the difficulty in finding consensus when calculating the VOLY.

The value of statistical life is another controversial method that puts a value on a human life but take a different approach from the VOLY. VSL is derived from “individuals’ valuation of the willingness to pay to reduce the risk of dying” (OECD). To calculate the VSL one must start with a survey to determine how much individuals are willing to pay to reduce their risk of dying from air pollutant related illnesses. This willingness to pay for reduce risk becomes the value of one life. In the OECD study on the cost of air pollution, they multiplied the VSL with the amount of deaths due to air pollutions to calculate a total expenditure value.

Productivity loss due to morbidity is a more complicated measure when calculating the cost of air pollution. According to the OECD, there is a lack of standard methods for estimating the cost of morbidity (OECD). Most studies that include productivity loss due to morbidity use a similar approach to the VOLY, but instead of using life expectancy they use loss of time working which creates a much smaller total expenditure. The significance in including morbidity as well as mortality, even though the expenditure difference is large is to include sick days due to air pollutions. How many individuals miss work because of air pollution? Morbidity can be used on a micro scale to assess annual losses by each employee of a certain company due to their air pollution related illness.

Lastly, quantifying damage costs in monetary terms is combined within the last three methods described. The ultimate goal is to calculate a dollar value for measuring industrial air pollution. VSL, VOLY, and productivity loss due to morbidity make that possible.

Throughout the literature reviewed for this research, the impact pathway approach has been apparent as a method for quantifying a variety of pollutants from different sectors. The Organization for Economic Co-operation and Development study on the cost of air pollution from transport uses this very method to quantify a final expenditure. They (1) identify pollutants: NH3, nitrogen oxides, non-methane volatile organic compounds, particulate matter, and sulfur oxides. Then (2) determined the impacts of emissions using VOLY data. And finally (3) quantified the damage in monetary terms as a final expenditure range of 329 billion EUR­2005 – 1053 billion EUR2005 (OECD).

**Emissions Market Value Approach:** The emissions market value approach includes two methods for calculating the costs of air pollution using market values for the resource itself. The first approach is the Emissions Trading System (ETS), a cap and trade approach to carbon emissions. Second, is a similar approach know as, “carbon offsets”. It is important to note that the following methods are currently primarily focused on carbon and beginning to be used for other air pollutants.

The ETS was created by the EU in an effort to address climate change and increasing CO2 emissions. It is an international system for trading emissions allowances. The EU sets a cap for the amount of total CO2 emissions allowed, companies are then given carbon allowances that cover their emissions. If a company exceeds their carbon allowance they are fined a great amount. If a company falls under their allowance, they can either save the allowances until next year, or sell to another company that may need more allowances. The EU lowers the cap after a certain amount of years to ensure reduction of emissions.

This cap and trade system of emission allowances sets a market value on carbon emissions. Depending on the cap, there is a monetary value for each allowance to be bought or sold. That monetary value is what is then used to calculate the cost of CO2 in an economy. In other words the cost of emissions to an economy are equal to the ETS allowance market equilibrium price.

This idea of ‘trading’ emissions is growing to other countries outside of the EU. It is an interesting model for reducing carbon and encouraging energy efficiency within companies. One major issue faced within the carbon allowance market is the volatility of the global economy. The global economic crisis following the 2008 US recession led to companies focusing less on emissions and more on production. It became too expensive for some businesses to maintain low carbon emissions and purchase more allowances.

The second market method is very similar to the cap and trade system in the sense that emissions are being commoditized. Carbon offsets value carbon emissions in the amount of money it takes to offset the environmental impacts of those emissions. For example, if one owned a coal plant with a certain number of CO2emissions, how many trees could they pay someone to plant offsite to absorb the CO2 emitted, and how much would it cost? That cost is considered the value of emissions according to the carbon offset model.

Growth in this model has gone beyond coal and trees, now industries can choose to offset their carbon by paying for initiatives such as wind farms, household device projects, forest protection from illegal logging, methane capture from landfill gas and agriculture, and reforestation because these projects reduce carbon and offset the damage to the environment. There are many flaws when using this method to value emissions. The primary issue with carbon offsetting is that it simply offsets the externalities from industry and does not promote more efficient/ cleaner emission reduction tactics. While this method has potential for measuring the costs of air pollution, by defining a monetary value for carbon, it is the least ideal estimate for these research purposes.