

EC386 – Introduction to Health Economics and Policy

**What is the impact of environmental pollution on public health? What is the rationale for government intervention to fight against pollution? Which policies might be implemented to tackle environmental pollution? \***

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## **Introduction**

The relation between human health and environmental pollution has been comprehensively studied, and environmental risks have been proven to significantly influence human health. This is caused either directly by exposing people to dangerous gaseous agents, or indirectly, through the degradation of ecosystems. Environmental agencies and government bodies have highlighted environmental pollution as a worldwide problem and an increasing global health concern. The most harmful form of environmental pollution to public health is air pollution – the introduction of poisonous emissions into the atmosphere (LiveScience, 2018).

The World Health Organisation (WHO) has estimated that “92 percent of people living in cities do not breathe safe air and 7 million people die prematurely every year from both household and ambient air pollution” (World Health Organisation, 2016: Online). WHO describes air pollution as the invisible killer since subsequent damage to health can be acquired during childhood, but manifest later in adulthood. The adverse health consequences of air pollution largely include respiratory dysfunction, reproductive complications as well as immunologic and neurologic impairments and cancer. WHO have organised a range of summits to encourage worldwide cooperation in tackling and reducing this global challenge and has been actively supporting communities around the world to address air pollution on a local, regional and national level. With improved technology and environmental understanding there is now greater awareness that outdoor, as well as indoor exposure to air pollutants can cause serious life-long health risks.

This paper will provide insight into how prolonged exposure to air pollution impacts the health of the public, explaining the rationale for government intervention in tackling ambient anthropogenic air pollution and the policies that could be implemented to deal with mortality and morbidity as a result of poor air quality.

## **Primary pollutants and air quality metrics**

There are two forms of air pollution. Type I air pollution stems from biogenic sources, including desert dust, wild fires and allergens, of which human activity has minimal influence. In contrast, Type II air pollution is produced by indoor anthropogenic pollution caused by tobacco smoke and household energy use, in addition to outdoor anthropogenic pollution such as particulate matter, Nitrogen Dioxide (NO<sub>2</sub>), Carbon monoxide (CO), sulphur dioxide (SO<sub>2</sub>) and Sulphur dioxide (SO<sub>2</sub>). Type II air pollution is worsened by the intensification of human activities, including the inefficient use of industry energy by burning fossil fuels and agricultural practises, of which are the main driving forces of environmental health problems (Greenpeace UK, No date).

Air pollution is measured using an Air Quality Index (AQI) which measures the presence of the primary anthropogenic air pollutants in the air. A high AQI status is associated with a poor air quality and thus provides an indication of the pollution levels in the air and the associated health effects that may be experienced with short term exposure (AirNow, No date). Each country sets air quality standards, that they must adhere to, dependent on political and social factors, technological feasibility and economic considerations that they face.

## **I Impacts of air quality degradation on human health**

### **Air pollution-related health complications**

Exposure to air pollution can result in a wide range of short- and long-term health effects. It makes people more susceptible to respiratory diseases and other illnesses, of which the severity depends upon on the type of air pollution exposure, concentration, length of exposure and individual characteristics. The impact of environmental on health can cause a spectrum of health effects, differing in terms of severity and medical significance. The effects of air quality on human health can vary from negligible symptoms such as nasal irritation to more severe illnesses like cancer, likely to reduce the quality of life and life expectancy. Air pollutants are mostly carcinogens and living in a polluted area can put people at risk of cardiovascular, reproductive, respiratory and cognitive damage. It is reported that an estimated 4.2 million premature deaths globally are linked to ambient air pollution, mainly from heart disease, stroke, chronic obstructive pulmonary disease, lung cancer, and acute respiratory infections in children (WHO, 2018).

Air pollution is responsible for 1.4 million deaths from stroke each year (WHO, 2018). The brain requires a high supply of oxygen and energy to function effectively. Carbon Monoxide, a toxic air pollutant that competes with oxygen once inhaled. It attaches to haemoglobin in the red blood cells, and in turn starves the brain of its vital oxygen supply, increasing the risk of stroke and may also cause less severe health outcomes such as headaches, depression and anxiety.

Of all pollutants, particulate matter (PM) has the greatest effect on human health (WHO, 2018). The health risks associated with particulate matter of less than 10 and 2.5 microns in diameter (PM<sub>10</sub> and PM<sub>2.5</sub>) is an especially well-documented cause for lung cancer, having been classified, by WHO as a ‘definite cause of cancer’ (WHO, 2018). Fine particulate matter is small enough to penetrate the deepest parts of the lungs and into the bloodstream, lodging in the heart, brain and other vital organs causing cardiovascular, cerebrovascular and respiratory impacts. It has been reported that air pollution causes 2.4 million deaths due to heart disease each year and causes 1.8 million deaths due lung disease and lung cancer. Breathing polluted air puts people at a higher risk of asthma and other respiratory diseases (GOV.UK, 2018). Epidemiologic studies have consistently supported an increase in respiratory and cardiovascular morbidity and mortality from exposure to particulate matter. Atkinson *et al.* (2001) found that particle concentrations in European cities are positively associated with increased numbers of admissions for respiratory diseases. Similarly, Dominici *et al.* (2006) found that short-term exposure to PM<sub>2.5</sub> increases the risk of hospital admittance for respiratory and cardiovascular diseases.

### **Victims of air pollution**

Long term air pollution exposure affects people of all ages, however specific segments of society are particularly vulnerable and more at risk of health degradation. The WHO identified woman, children, and outdoor workers are most likely to bear the brunt of poor air quality.

Air pollution causes over half of all child deaths from acute lower respiratory infection in children under 5 years in lower middle-income countries (WHO, 2018). Many reasons explain why the adverse health risks linked to air pollution

exposure for unborn babies and infants are the greatest. A factor that influences a child's exposure to pollutants is height, because children are much shorter than adults, they are at level with the exhaust pipes of vehicles. Exposure to air pollution at a young point in their life can lead to permanent damage, such as a lesser developed respiratory system, which in turn reduces lung capacity, stunts brain development and increase the risk of conditions such as asthma. Currie (2011) investigated the effects of automobile congestion on ambient air pollution and local infant mortality rates using data from California, spanning 2002 to 2007 and found that in the U.S. reductions in prenatal exposure to traffic congestion could reduce preterm births by as many as 8,600 annually.

Household air pollutants have also been connected to development of various types of cancers and the intensive use of solid fuels like charcoal and kerosene is significantly contributing to air pollution in developing countries that are reliant on them as a source of energy. African women suffer the most from the harmful consequences of pollution, working in smoky biomass-fuelled stoves and therefore being exposed to household air pollution. 90 percent of the Africa's population is exposed to indoor air pollution due to the dependence on biomass fuels for heating, cooking and lighting (United Nations Environment Programme, 2017). The health effects of pollution fall most heavily upon the world's poor, and more than 90 percent of pollution-related deaths occur in low-income and middle-income countries as they have access to less energy cleaning technology (United Nations Environment Programme, 2017). This, in addition to Africa's increasing urbanization and poor urban planning, means people are living in overcrowded, poorly serviced housing which worsens the issue of pollution on health outcomes.

Agricultural workers, construction workers, and traffic wardens, are particularly vulnerable to ambient air pollution. Outdoor workers spend long hours in traffic and exposed to high levels of nitrogen oxides in diesel vehicle emissions, known to decrease pulmonary function and increase incidence of respiratory and cardiovascular disease. In addition to breathing greater atmospheric pollutants, the outdoor workforce is often exposed to other environmental risks, namely biogenic pollutants in the form of dust and allergenic pollens.

## **II Incentive for government to fight against pollution**

There is a convincing evidence for action to be taken to reduce public exposure to polluted air, improve people's quality of life and save the lives of many. Policy interventions to encourage cleaner air can result in substantial monetary savings for the government in terms of healthcare costs (particularly within countries such as the UK with tax funded national healthcare), greater tax revenue from imposing green-tax and the avoidance of fines for adhering to environmental guidelines.

### **Economic costs**

Air pollution can impact the health of the labour force, which has consequent economic effects, if the reduction in well-being results in greater workplace absences. Air pollution can cause a spectrum of health effects and intensify medical conditions such as asthma, coronary heart disease, and strokes, further reducing quality of life. In 2012, Defra estimated the impact poor air quality had on productivity, cost the UK economy £2.7 billion (GOV.UK, 2018). Moreover, this

means that people are less able to work and require more medical care, causing higher costs to society and burden on National Health Service (NHS). Although difficult to quantify, studies have attempted to predict the economic valuation of the health impacts caused by air pollution. Air pollution related healthcare costs may cost much as US\$130 billion per year for Organisation for Economic Co-operation and Development (OECD) member countries (OECD, 2001). A series of studies by Pearce *et al.* (1996) also estimated the monetary costs of pollutants with costs to the U.S. economy ranging from \$2 per tonne of carbon emitted to \$500 per tonne. Moreover, reducing air pollution can result in substantial savings to the government from air pollution damage, related to, health expenditure and infrastructure repairing.

### **Tax revenue**

All countries have made an attempt to enforce environmental taxes, with varying degrees of success. More countries however, are beginning to implement stringent green-tax reforms. The designs of these environmental taxes vary according to the environmental situation and the country's economic and fiscal landscape. Environmental taxes penalise the polluter, reflecting the cost of pollution in the price to consumers and production output, and in turn the level consumed. On average, the tax revenue from green-taxes constitutes roughly 2 percent of GDP and 6 percent of the total tax revenues of OECD member countries, thus representing a significant proportion of revenue for all member countries (OECD, 2001).

Research from the OECD database revealed between 1994-98 Denmark was the only country where the revenues from green-taxes constituted the greatest proportion of GDP, while Korea, Turkey, Portugal and Greece, were economies with the greatest contribution in total tax revenues (OECD, 2001). The substantial contribution of green-taxes in proportion to GDP for these countries, enforced the significance of environmental taxes such as fuel tax in their tax framework. The revenue generated could ultimately alleviate a budget deficit, finance increases in government expenditure on other sectors of the economy or address of other environmental problems.

### **Regulations and penalties**

Countries are monitored by independent bodies to encourage active prevention and control their level of air pollution, and face substantial penalties when air quality standards are not maintained. The European commission, an independent body that governs all EU member countries, has the control to issue multimillion-euro fines and administrative penalties up to \$37, 500 per day, per violation, to federal agencies for non-compliance of environmental guidelines. Fines and penalties act to disincentives illegal levels of air pollution and encourage non-abiding countries to take action to improve public air quality (EPA, 2018).

## **III Policies that might be implemented to tackle environmental pollution**

Addressing air pollution is moving higher on the global agenda and both government bodies and environmental agencies are working towards intersectional cooperation. Air pollution is a negative externality, as it imposes short-term and long-term negative health risks to the general public, a third party to a transaction during production or consumption decisions. Externalities exist due to the public goods nature (non-excludable and non-rival) of clean air. When the social

costs of pollution are not considered in the price level, market failure occurs, resulting in the excessive consumption and production of products that for example result in the burning fossil fuel at the expense of social welfare.

To tackle the major causes of ambient anthropogenic air pollution, the government can impose three major policies. The basic theoretical premise is to internalise the impact of their production decisions to society and future prosperity, by issuing punishments and incentives of which hold polluters liable. These policy instruments include tax to increase the price level, the provision of subsidised environmentally friendly alternatives and legislation to give polluters the flexibility to choose innovative, cost-saving methods in reducing or restricting their emission of harmful pollutants.

### **Legislation**

The European Commission has enforced several legislations, which set strict ambient air quality limitations to the amount of pollutants in the air of its EU member states. The main advantage of this type of legislation is that authorities form clear objectives and ensure pollution levels are monitored and reduced, rather than depending on the enforcement of market incentives, which have a stronger risk of failure. On the contrary, critics could argue command and control regulation can be difficult to enforce, because economies have varying traditions and consumer habits and will therefore have differing strategies to achieve the pollution level targets. Local and national government interference may be needed e.g. in the form of taxes, as well as legislation to ensure air pollution targets are met efficiently.

### **Policy issues for developing countries**

Developing countries are greatly impacted by the health risks of air pollution and due to poverty, the absence of investments in modern technology and poor environmental regulation serves to exacerbate the issue. Household air pollution is one of the world's single biggest environmental health risks, particularly in developing countries (WHO, 2018). The most effective policy instruments to tackle this are tailored to each country. Developing countries, with low to middle income suffer from poor energy usage and the lack of renewable energy production and use. Governments can introduce new protocols, fund new innovation as well as fund the derivation of air quality data and statistics for monitoring and forecasting purposes, fundamental to guiding new policyies to enhance air quality. Long-term exposure of burning wood fuel, coal or kerosene lamps releases toxic fumes that cause health risks and disease. Effective policies and incentives reduce the barriers for purchasing cleaner technologies such as cleaner cook stoves or fuels for heating and lighting and cooking by making purchases affordable for low income households. Other policies seek to encourage the manufacture and distribution of clean household energy to increase the supply and availability to consumers. Policies need to be tailored to urban economies as well as isolated rural areas and cultural habits ,such as investments in solar and wind power so clean energy is affordable for all (WHO, No date).

According to the Ministry of Environment, every year in Chile, air pollution costs the health sector at least \$670 million and is the root cause of more than 4,000 premature deaths (UN Environment, 2017). To address this challenge, in 2014, the Government launched a strategy to replace 200,000 wood fuel heaters with energy-efficient heaters such as gas,

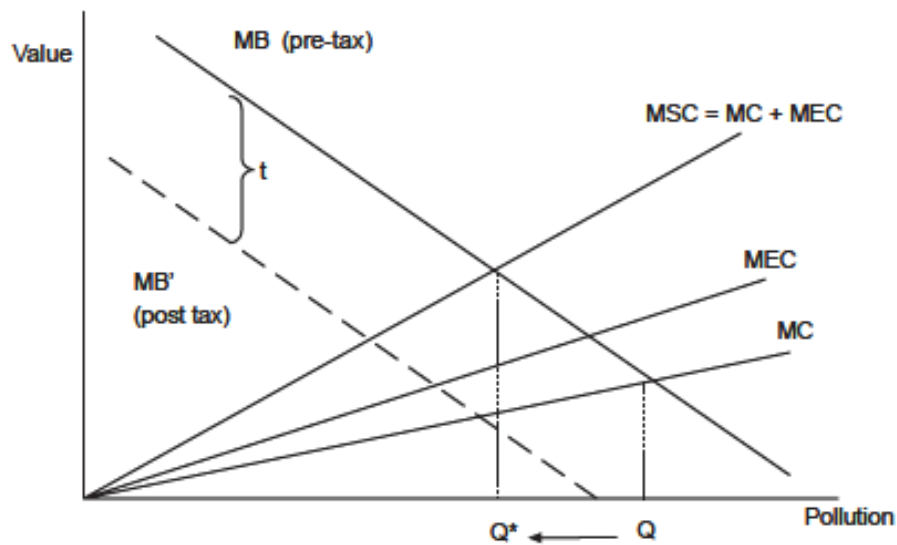
paraffin-based heaters, which has since resulted in significant reductions in emissions and improved indoor air quality (UN Environment, 2017).

**Taxation**

‘Green tax’ such as Carbon tax or motor vehicle tax are one policy instrument that charge the polluter per unit of pollution, a tax of which is determined by a federal body, with the aim of making economic agents bare the full social cost of pollution. This policy creates incentive for private firms to restructure away from high pollution producing products to improving production practices, in turn reducing pollution.

Nordic countries were the pioneers of green tax reforms. Finland was amongst the first countries to introduce taxes specifically targeted to reduce carbon dioxide emissions, introducing the carbon tax on the use of fossil fuels in 1990. The revenue generated from Finland’s green taxes has since been used to counterbalance the revenue losses from tax cuts on labour. Sweden soon followed in 2001, with taxes levied on diesel consumption for heat, oil and electricity (GOV.UK, 2017).

**Figure 1. The socially efficient level of taxation**



Source: OECD (2001)

Figure 1. illustrates a basic model of the effect of negative externalities on the market and a remedial taxation to correct the issue. According to economic theory, the efficient level of a given air polluting activity is achieved where the marginal benefit (MB) of emitting an additional unit of pollutant emitted in the air, is equal to the marginal social cost (MSC) of that activity. MSC comprises of the private marginal cost (MC) and the Marginal environmental cost (MEC), of an additional unit of pollution emissions in the air. In unregulated economies, private entities release pollution at amount Q, the point at which marginal benefit (MB) is equal to the marginal private cost of air pollution. The introduction of an indirect ‘Green tax’, at the optimal rate of t units of pollutant emissions, reduces air pollution emissions to the socially optimum level, Q\*. Following the introduction of the Green tax, the MB curve shifts to MB’,

forcing private entities to internalise the environmental damage of their activity by modifying their production behaviour via price signals. Moreover, this results in a reallocation of resources to level  $Q^*$ , that allows for the greatest social benefit and reduced pollution (OECD, 2001).

Policymakers can also use other types of market-based policy instruments available, aside from taxes. Other economic measurements include tradable emission permits, non-compliance fines and environmentally friendly subsidies.

### **Subsidies**

Taxation may be ineffective in deterring negative production practises such as burning coal, however if the government subsidises environmentally friendly fuel alternatives like biofuels, then firms and consumers will be more prepared to change their behaviour. A government subsidy can make biofuels competitive and therefore support its development and encourage its use. Subsidies as such are defensible, as the use of biofuels yields positive externalities, unlike burning fossil fuels.

The government could also provide grants to low income households to improve the housing conditions of families and subsidise the cost of insulation. Adequately insulating households is estimated to reduce demand for heating by 30 percent, critically lowering energy bills and emissions for under resourced families (UN Environment, 2017). However, the challenge faced with issuing subsidies is that there is risk that government subsidies could be abused. If governments do not properly monitor their use by firms, firms may accept the subsidy but keep the money as profit instead of developing an alternative cleaner energy source. The government may not have the knowledge and expertise of what energy sources and firms to subsidise which could ultimately result in with public money being wasted and little improvement to air quality.

### **Conclusion**

Air pollution poses a substantial risk to universal human health and has remained a major concern worldwide. Hazardous consequences of this degradation to human health are currently being felt and have been estimated to excessively worsen over the next 50 years, if sustainable action is not taken. Considering the environment and health are so closely correlated, it can be argued that a similar relationship between the environmental and health policies should ensue. The impact to health by air pollution has proven difficult to quantify in monetary terms, and so the consequent risks to public health and pressure for urgent action have continuously been overlooked in policy-making decisions.

The challenge is that improving air quality relies heavily on the collective efforts of a broad range of stakeholders including governments, industries and individuals. Industries can take steps to reduce pollutant emissions and switching to lower carbon-content (cleaner) fuels, thus having greater regard for the effect their production decisions have on future generations. Policymakers can create new air measures, fund the developing technology to reduce emissions and issue serious consequences to the polluters that breach these. On an Individual level, people can choose energy efficient means of living and transportation. Governments can also stringently follow WHO guidelines to take preventative action or curtail ambient and household air pollution altogether. Since environmental pollution affects all individuals and



institutions in society, all stakeholders must take action to reduce the burden of air pollution related disease and risk to public health.

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